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SCIENTIFIC MAN-POWER IN GREAT BRITAIN

THE recent debates on defence and on man-power in the House of Commons have one feature in common. Through the more responsible speeches there ran a thread of anxiety as to the man-power resources of Great Britain; whether that distribution was, in fact, the most appropriate for current and future needs, and whether the most effective use was being made of man-power in the occupations where it is at present deployed. In the defence debate, concern as to the actual targets for man-power was expressed on the Government side of the House, notably in regard to recruiting both for the Army and for the Air Force. Further, the Minister of Defence referred to his intention of expanding the research staffs in the scientific services, which for the last two or three years have been kept below the desired strength because of what were regarded as the more urgent claims of the universities, the teaching profession and industry, in accordance with the priorities recommended in the Barlow Report on scientific man-power.

In the man-power debate, however, the note of anxiety was more apparent on the Opposition side. Sir David Maxwell Fyfe pointed out that the Economic Survey for 1949 suggests that the Government no longer considers a better distribution of man-power to be an urgent necessity. While the personnel of the public services has continued to increase, the higher man-power targets for the basic industries of coal, agriculture and textiles have not been achieved. The Minister of Labour, Mr. Isaacs, claimed in his reply that in the greater part of the field the estimated distribution of man-power has been achieved, and he did not appear to be seriously worried by the admitted failure to attain the targets for the basic industries. He claimed that there is little to be done by way of distribution of man-power, and that the objective must now be increased productivity or higher output.

The importance of that objective cannot be overstressed; but there is far too large a proportion of the nation's man-power and woman-power engaged in what are essentially non-productive occupations for the question of distribution to be dismissed so lightly, quite apart from the repercussions of one section of the field on another. One undercurrent in the defence debate was a marked anxiety as to whether under the National Service Acts we are getting the right type of Army and Air Force; and, though the question was not asked, it was clearly in the minds of members that, despite the inherent justice of national service when fairly applied, it is scarcely compatible with a highly efficient long-service regular or professional army, or even with a territorial army.

The reality of the disruption and disturbance caused by national service cannot be denied. Whatever advantages a period of national service may have for many, for some it has real disadvantages: they become unsettled and are slow to adjust themselves to a civilian life and efficient production. This

may in part be a by-product of life in the Services under conditions of peace-time, and may possibly be mitigated as we succeed in eliminating waste in the Services themselves and utilizing civil personnel more effectively for non-combatant duties. On the other hand, it may be inherent in the system, and the consequent inefficiency and waste a part of the price to be paid.

The interruption of university training is another matter, and even if the vast majority of students do their national service before entering the university, some waste of talent is unavoidable. At the present time this is a serious matter for those firms who wish to expand their research and other scientific staff to seize what may be fleeting opportunities so far as export trade is concerned. It was announced last month by the Ministry of Labour and National Service that there will be no allocation to industry of science and engineering students completing their normal courses at universities and technical colleges in 1949. The only students allowed to defer their military service, apart from a small number taking up special posts in agriculture or coal mining, will be those who are allowed to continue at the universities in postgraduate research, for example, and a small number allocated to priority posts in the Scientific Civil Service. The former of these will in any event be required to carry out their military service before they attain the age of twenty-six. Once the principle of national service is adopted, it is clear that on grounds of equity there should be no exceptions; nevertheless, the policy thus announced is *prima facie* reasonable. Certainly, on economic grounds it is undesirable to employ a professionally trained scientific man or engineer in any capacity other than that for which he is professionally qualified, even in the Services; this is in itself a further argument for the completion of military service before admission to the universities. Nevertheless, the application of the policy will be viewed with dismay by firms which are already experiencing acute difficulty in recruiting scientific staff and which do not share the optimism of the Ministry of Labour as to the numbers available of trained scientific workers and technologists.

It is not only industry that is affected. At the annual meeting of the Carnegie Trust for the Universities of Scotland in Edinburgh on February 21, the complaint was made that Government departments, as well as industrial concerns, were outbidding the universities for their staffs, and that in open competition for brains, scholarship and particularly character, the Scottish universities were severely handicapped by lack of means.

This position has not, of course, escaped the notice of the University Grants Committee, and in the House of Commons on March 15 the Chancellor of the Exchequer said that he accepted the view of the University Grants Committee that the increase of salaries which had become necessary in the medical faculties carried with it, as a necessary consequence, a revision of salaries in the other faculties. The provision made for the universities in the Civil Estimates for 1949–50 will allow supplementary grants to be made to adjust such salaries as from October 1, 1949, on the basis of £1,600 for professors (in London, £1,650), up to £1,600 for readers and senior lecturers, £500–1,100 for lecturers and £400–500 for assistant lecturers. This announcement indicates that steps will be taken to rectify a situation which has been regarded with increasing concern by one body after another that has looked at university finance in recent years.

Nevertheless, that is not the most important aspect of the situation. The central fact to be realized is that a satisfactory distribution of scientific and of general man-power and a correct overall policy may be distorted by action taken to rectify an admitted weakness, or even grievance, in one particular field, because of its repercussions in other sectors. Quite recently, reference was made in these columns (see *Nature*, December 25, 1948, p. 977) to the new tensions which the recommendations of the Spens Report threatened to introduce, particularly when the operation of the economic factors which would normally restore the balance was retarded. Further point is given to those comments by the announcement on March 17 of the salaries and conditions of service for specialists in the new health service which, based on the recommendations of the Spens Committee, the Government proposes to adopt. We are here only concerned with the fact that the standard set for specialists is bound to influence the earnings of other medical men and, through them, the earnings of other professions. The importance of the financial motive can be over-estimated; but it is sometimes a decisive factor in the choice of profession and, perhaps more important still, in the choice of occupation within a profession. To use it without much forethought and careful preparation to adjust the distribution of man-power within a profession is a delicate operation and liable to be attended with awkward and undesirable effects elsewhere.

Although it is a tool to be used only as a last resource, the economic motive is one that cannot be ignored. Hitherto, the professional classes generally have exercised considerable restraint in the matter of remuneration during an inflationary period. The Parliamentary and Scientific Committee has therefore done well to appoint a broadly based sub-committee to inquire into the whole subject of payment of scientific and medical teaching staff at the universities, and the general effects on those of similar standing in other spheres. In that unenviable task, they may well find some whose training is far more exacting and starts at a much higher intellectual level than that of the medical graduate but whose financial rewards are far lower; they may well also uncover unfounded claims to higher personal incomes. A report from so representative a committee may be invaluable in restoring some balance and sense of justice.

Economic factors are, however, only one disturbing element; but they well illustrate the way in which Government action itself may have repercussions which affect the distribution of man-power and the balance it desires. More, they remind us that the distribution of man-power is a dynamic and ever-changing element in the nation's affairs. It is rarely

static, being affected by internal changing circumstances such as technological developments, and also by external events. Man-power policy can never be finally determined. It must be reviewed continually in the light of the needs of the day, and with the fullest possible informed public discussion, if the Government is to be sure of the public support without which no man-power policy can succeed.

Vital as it is to secure maximum productivity, neither industry nor the nation can afford to accept the view that the distribution of its workers does not require continuous, rigorous and impartial scrutiny. Before embarking on a policy of continued expansion of the Government services, the Minister of Labour should satisfy himself—and also industry and the universities—that there are weighty reasons for it. In view of the general restriction of research activities outside the Government service, due to the present shortage of scientific man-power in Great Britain, the case for increased staffs in Government establishments and the Service departments requires careful consideration.

CHEMISTRY OF THE CAROTENOIDS

Carotinoide

Von Paul Karrer und Ernst Jucker. (Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften, 17: Chemische Reihe, Band 3.) Pp. 338. (Basel: Verlag Birkhäuser, 1948.) 43 Swiss francs.

POSSIBLY no better example can be found of astonishingly rapid development of the chemistry of a widely distributed and exceedingly complex group of natural compounds, following upon the introduction of micromethods and specially devised processes, than is afforded by the carotenoids. The first monograph devoted to this topic, "Carotenoids and Related Pigments" (by L. S. Palmer; New York, 1922), contained virtually no detail of structural significance, though this was soon to appear (see, for example, "Carotenoide", by F. Meyer in Meyer–Jacobsen's "Lehrbuch der organischen Chemie", first and second editions, vol. 2, chapter 5; 1929). The adoption of micromethods of oxidation and reduction, the recognition of light absorption of the carotenoids as a valuable characteristic, and, above all, the timely revival of chromatographic analysis, without which the development of carotenoid chemistry might well have been delayed for years, resulted in a surprisingly swift revelation of the main outlines of the chemistry of natural polyenes.

For fifteen years L. Zechmeister's "Die Carotinoide" (Berlin, 1934) has been the sole text dealing exclusively with this detailed carotenoid chemistry. These years, despite the attention of chemists in many countries having been directed elsewhere, have seen much in this field beyond the normal addition to what was known of structural detail. This growth has certainly been notable, for there are now some seventy known naturally occurring carotenoids, the structure of about 50 per cent of which is now fairly precisely elucidated, together with a very large number of stereoisomerides and polyene degradation products. The carotenoids are no longer, however, of interest solely to the academic chemist concerned with the structural patterns of natural molecules. Connexions with vitamin A, visual purple, phototaxis, and even fertilization in micro-organisms, among other topics, afford them outstanding biochemical interest, and it may be said at once that in the volume under review this old and new material has been surveyed and mostly reproduced in all essential detail in masterly fashion.

All that the chemist can reasonably expect in respect of historical data, occurrence, preparative detail, physical and chemical characteristics, derivatives, and original references to individual pigments is set out with exemplary clarity and, it seems, accuracy, in the special section of this book. Readers will be specially grateful to the authors for having withstood the temptation to abbreviate the necessarily cumbersome structural formulæ, as well as their lavish use of tables and the inclusion of representative spectral curves and coloured plates of carotenoid crystals.

General occurrence, determination of structures, physiological significance, and, among other features, distribution of the carotenoids are summarized with scholarly precision, often in tabular form, in a general part; all information such as the organisms producing specific pigments and the pigments produced by specific organisms is made almost instantly accessible, and few facts only (for example, work on vitamin A) seem to have escaped inclusion, obviously because of their recent discovery.

This is in every way a finely produced and very timely work which, so far as can be foreseen, will be the standard text and largely meet the needs of workers in the field of carotenoids for some considerable time ahead.

A. H. Cook

GEOLOGY AND GLACIOLOGY OF THE PLEISTOCENE PERIOD

Glacial Geology and the Pleistocene Epoch

By Prof. Richard Foster Flint. Pp. xviii+589+6 plates. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 36*s*. net.

PROF. R. F. FLINT'S distinguished work in the broad field of glacial geology has been prominent for a generation, and his book is important for that and for other reasons. It deals with the Pleistocene period from the points of view of a geologist and of a glaciologist. Characteristically, perhaps, the author has used stream-terrace data as little as possible, and indeed much of the field work in North America lends itself to the successful pursuit of other methods. Correlation, perennially a difficult subject, is treated so far as possible on geological evidence, not on archæology. The author strives to avoid deduction from any theory of climatic fluctuation which sets up a fixed chronology; he incorporates with his own wide knowledge and experience a considered opinion of an enormous amount of literature, of which a formidable list occupies some forty pages. Significant is the author's introductory statement that "a continuous effort has been made to discriminate between reasoning by induction from field evidence and reasoning by deduction from assumed general conditions"; and there, in a sentence, lies the duty of every scientific worker in the field, laboratory and library.

The book is dedicated to Max Demorest, who lost his life while going to the aid of others in Greenland during the War, and his important contributions to glaciology are incorporated in the author's essential thesis on ice movement. Ten of the twenty-three chapters are given to an objective study, well documented, of glacier ice, its motion and regime, form and distribution, powers of erosion and deposition, periglacial deposits, and glacial stratigraphy. For many, these careful and up-to-date essays will be the *raison d'être* of the book. But sober and engrossing chapters follow on the glacial stratigraphy of North America, Europe and other lands, on changes of level of sea and land, on Pleistocene chronology and climates, on the causes of climatic fluctuation, and the fossil record. Specialists, each in his own field, will be able to supply references and data which will post-date some of those given in the book; some of the subjects are notoriously controversial, but, in the reviewer's opinion, Prof. Flint has dealt faithfully with the past and kept a keen eye to the future of many and varied researches.

The text is well illustrated, with a large number of photographs, some of them excellent, new and intriguing text-figures, tables of correlation and of estimated volumetric data on glaciers, both past and present. Folding plates at the end of the book show the present distribution of land ice, pack ice and storm tracks in southern and northern hemispheres; and stimulating impressions of the same features in the latter hemisphere during the last (Wisconsin) Glacial Age; distribution of loess (in particular) in Europe; glaciated areas in the western United States (with form-lines based on the general altitudes of the floors of the lower cirques); and a sketch-map of the glaciations of Europe. Author and publisher are to be congratulated on the general appearance and presentation of text and illustrative material.

"Glacial Geology and the Pleistocene Epoch" must surely become a standard work of reference; but it is more than that because it is a balanced, objective, creative, and stimulating book, written for an educated public rather than for a few specialists.

K. S. SANDFORD

APPLICATIONS OF GROUP THEORY TO SOME PHYSICAL PROBLEMS

Theory of Groups and its Application to Physical Problems

By S. Bhagavantam and T. Venkatarayudu. Pp. xi+234. (Waltair: Andhra University, 1948.) 20 rupees.

IT is an obvious truism to say that the day is long past when each 'branch' of science was placed in a separate water-tight compartment on its own, divorced from all the other 'branches'. On the contrary, it has become increasingly clear in recent years that these 'branches' are unified in one collective science, and that an advance in one 'branch' will often lead, at a later date, to an advance in some apparently totally different field of investigation.

This is particularly true when the former field is pure mathematics. Thus, the early work on infinite matrices, and the famous book of Courant and Hilbert, "Methoden der Mathematischen Physik", 2 vols. (Berlin: Springer, 1924 and 1937), provided just what was wanted for the development of the Heisenberg–Dirac theory of quantum-mechanics; then linear operators in Hilbert space paved the way for a mathematically sound discussion of Schrödinger's wave equation, and led to proofs, by von Neumann and others, of the spectral resolution theorem for unbounded self-adjoint (hypermaximal) operators. Again, in 1913, by use of the Baire–Osgood theorem that the continuum is not a set of the first category, Plancherel and Rosenthal gave independent proofs of the impossibility of the Maxwell–Boltzmann theory of gases.

Now, in the book under review, the authors provide a lucidly written and well-designed exposition of the application of another abstract branch of pure mathematics, namely, group theory, to some physical problems. The book is exactly what the authors claim it to be, namely, a self-contained and connected account of the above application, intended for those who have no ready access to orthodox treatises already written on the subject. As such, it does not contain novel results, but shows the application of a mathematical tool to existing knowledge. A commendable feature of the book, which is of a mathematical nature, is that physical arguments are not glossed over, and all the results are discussed in detail.

After some introductory chapters on groups and lattices in one and two dimensions, applications of group theory are given to vibrations of a dynamical system, vibrational Raman effect and infra-red absorption, some simple molecules, lattices in three dimensions, vibrations of a crystal lattice, Raman scattering in crystals, rotation groups, problems of atomic spectra, electron spin, some aspects of band spectra, etc. There are also useful appendixes on various matters arising from the text.

In a foreword, Sir C. V. Raman writes of the book: ". . . It represents a serious effort to present a branch of mathematics which is of great and growing importance to physicists generally in a manner which will appeal to and interest them. I believe that the book will be widely read and appreciated." The present reviewer entirely endorses this opinion, and hopes that the book will be read, not only by physicists and applied mathematicians, but also by pure mathematicians who are not too 'pure'.

R. G. COOKE

WOODY PLANTS FOR AUSTRALIAN GARDENS

Shrubs and Trees for Australian Gardens

By Ernest E. Lord. Pp. xxiii+453+125 plates. (Melbourne and Sydney: Lothian Publishing Co., Pty., Ltd., 1948.) £5 5*s*. 0*d*.

THE flora of Australia is one that has always attracted the horticulturist as well as the botanist, both on account of the beauty of many of its species and also because of the high proportion of endemic types. The present work, which is written in non-technical language by a landscape architect and former curator of parks, treats of the trees and shrubs grown in Australia with respect to their horticultural value. To this end the descriptive matter is not such as to serve for the identification of species, but rather for assessing their garden significance and appropriateness for diverse purposes. Sections treat of the trees and shrubs recommended for the various

climatic zones in Australia and for special requirements such as for town and roadside planting, those suitable for arid conditions, for the seaside and for small gardens.

The admirable illustrations portray some hundred and fifty species, and of these fifteen are represented in colour. It is scarcely surprising to find that the characteristic Australian family of the Proteaceæ occupies a prominent place among those of especial garden merit. The beautiful crimson *Telopea truncata*, a tree from Tasmania that attains a height of 20–30 ft., is portrayed in its natural colour, but the West Australian *Banksia prionotes* and *Banksia coccinea*, the former a yellow-flowered tree and the latter a crimson-flowered shrub, have a beauty of form to which the black-and-white photographs do full justice. Other noteworthy illustrations from the same family are *Dryandra formosa*, *Hakea laurina*, *Isopogon anemonifolia* and *Stenocarpus sinuatus*. Of the endemic Epacridaceæ, the figure of *Sprengelia incarnata* is especially effective, while the Rutaceæ are illustrated by the charming Correas and Boroneas, which emphasize the relationship of this family with the Ericaceæ. From the Myrtaceæ come the eucalyptuses, the true bottlebrushes (*Callistemon*), and their close relative *Calothamnus*, while mention must be made of the magnificent specimen of *Helichrysum thyrsoideum* and of the interesting blue-flowered Boraginaceous shrub, *Halgania cyanea*.

It is unfortunate that, in endeavouring to compass the trees and shrubs of a continent within the compass of a single volume, so little space could be devoted to each and so little data furnished as to soil conditions. Moreover, despite the desirability of avoiding technicalities in a volume of this character, the absence of any indication as to affinities is to be regretted, since the family to which an unfamiliar subject belongs is often a valuable indication to an experienced gardener as to treatment.

E. J. Salisbury

CONDUCTION OF ELECTRICITY IN METALS

Leitfähigkeit und Leitungsmechanismus fester Stoffe
Von Prof. Eduard Justi. Pp. xii+348. (Göttingen: Vandenhoek und Ruprecht, 1948.) 15 DM.

THIS book originates from a lecture course which the author, himself an experimental physicist, gave during the War to an audience consisting largely of electrical engineers, with the aim of bridging the gap between the outlook of engineers and physicists. The book covers a field somewhat wider than the original lectures and is written partly in collaboration with experts on special subjects.

The specialization of science has been widely commented upon, and its dangers for the future of science and human thought in general are recognized. Since this book is published with the purpose of counteracting some of the detrimental effects of specialization and establishing stimulating contacts between the worlds of science and industry, it should be welcomed.

Conduction in metals is a phenomenon on which the routine work of electrical engineers is founded, and the author conveys the views of modern physics on the subject to a public to whom presumably even the older physics is not too familiar. This is done by discussing conductivity in terms of moving electrons and reviewing all other phenomena through which the dynamics of electrons in crystals is accessible to observation, such as the Hall effect, thermo-electricity, superconductivity, rectification in surface layers, semiconductors, photoconductivity, ionic conductivity of crystals and similar subjects.

The book is written as a review rather than as a treatise. It consists of accounts on the experimental work in various fields. The author lets the experimental facts speak for themselves and refrains from stressing opinions of his own. Theories are not presented in full, but theoretical results are freely quoted when this is necessary in discussing experiments. There is, however, an elementary introduction to the wave mechanics of electrons in metals.

An apparatus is described by means of which the interference of electrons was demonstrated in the lecture theatre in such a way as to impress the wave nature of matter on the largely non-academic audience. The author is anxious to point out the possible practical applications of phenomena that are, so far, of academic interest only, and he reports, therefore, in detail on the experimental work on the utilization of the free energy of fuel in galvanic cells.

The ample lists of references are obviously supposed to cover everything of importance, including recent work. Heisenberg's papers on superconductivity are quoted; but there is no reference to the recent electron theory of electric breakdown[1].

The book will be useful, in the first instance, to those readers who are interested in the facts rather than in their interpretation. It provides plenty of information for the non-expert, academic or industrial, and may be appreciated even by experts for reference purposes.

R. Eisenschitz

[1] Cf. Fröhlich, H., *Nature*, **158**, 332 (1946).

FOOD CROPS

Brassica Crops and Allied Cruciferous Crops
By Chas. H. Oldham. (Agricultural and Horticultural Series.) Pp. 296+20 plates. (London: Crosby Lockwood and Son, Ltd., 1948.) 21*s*. net.

Grain Crops
By Harold K. Wilson. (McGraw-Hill Publications in the Agricultural Sciences.) Pp. xi+384. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 24*s*.

THE production of food continues to be of vital importance to mankind, and there is no dearth of books for the guidance of cultivators. In the two books under review there is a wealth of information on the growing of bigger and better crops.

In "Brassica Crops and Allied Cruciferous Crops" the author has collected together from various, and often inaccessible, sources accurate information about modern methods of growing and marketing vegetables, and has incorporated the results of his own wide experience and observations. He has also given useful descriptions of the varieties generally grown. All this is arranged in thirteen chapters, one chapter for each vegetable, and each chapter is of precisely the same pattern, comprising sections on botanical and historical features, the principal types and varieties, geographical areas of production, maintenance of pure stocks and production of seed, cultivations, marketing, diseases and pests. The alphabetical arrangement of the chapters is con-

fusing, as it involves, for example, the separation of the savoy from the cabbage by no less than six chapters, although both vegetables have many features in common. A more natural sequence would have been obtained by discussing the vegetables of the *Brassica* genus in consecutive chapters.

The book is well illustrated by drawings and photographs, and there is an excellent index. The botanical information is not always accurate, one obvious inaccuracy appearing in Fig. 1, in which the siliqua of the wild cabbage is depicted dehiscing from the apex towards the base. Such details, however, do not detract from the value of the book to the practical man, and commercial growers and private gardeners alike will find this volume invaluable.

"Grain Crops" is an expansion of outlines of a course of lectures on the various phases of the production of grain crops, given to students in the College of Agriculture, University of Minnesota. The subject-matter is arranged in twenty-three chapters, of which the first eight are concerned with a very brief review of the fundamentals of botany, plant classification, the world distribution of grain crops, and a general discussion of their culture. This section is followed by a more detailed discussion of individual grain crops, and these include not only the members of the grass family but also such crops as flax, buckwheat and soybeans. The book concludes with a chapter on the improvement of grain crops.

Each chapter is followed by a list of review questions and a bibliography; but one seeks in vain for a reference to any literature other than American. With the exception of the mention in a footnote of "The Wheat Plant" by John Percival, all literature published outside the United States is ignored. The whole subject is treated purely from the American point of view, since crop rotation, methods of culture, lists of varieties, storage and uses of the various crops all refer solely to American conditions.

While this book is undoubtedly very useful for the American agricultural student and the American farmer, it is of very limited value to agricultural students in Great Britain or, indeed, in many countries outside the United States. The omission of references to work on grain crops by men of science in other countries emphasizes this statement, and surely the "more advanced students", mentioned by the author in his preface, would profit enormously if the "liberal use of selected references" was more truly liberal and indeed international. A. G. ERITH

CRYSTAL STRUCTURES OF INORGANIC COMPOUNDS

Crystal Structures

By Ralph W. G. Wyckoff. Section 1. Pp. viii + 442. (New York and London: Interscience Publishers, Inc., 1948.) 48*s*.

IN 1931 Dr. R. W. G. Wyckoff's "Structure of Crystals" was published and was followed by a supplement in the year 1934; these volumes contained the results of crystal-structure determinations up to about 1933, and many X-ray crystallographers will have found them of utmost value, both as sources of information about structures and as sources of references.

The present work will therefore be greeted by many as an old friend, and they will not be disappointed in its contents. The sections on crystal-structure determination have disappeared, while the discussions of structures and the relationships between them have been extended in the light of recent theories. The details of the structures are repeated from the earlier volumes, together with the well-known diagrams, but the references begin at the year 1933, where the first supplement finished.

There are, however, many changes. The book is published in loose-leaf form, and is printed in imitation typescript; only about half of the book is yet produced, and the rest is to be published in two sections. The author has adopted this method of procedure in order that the main part of the book could be published within a reasonable time; corrections may be made later by the substitution of pages, and new material can be added in appropriate places. The part so far produced is on inorganic structures, arranged in order of complexity of chemical formula —elements, compounds AB, compounds AB_2, etc.— and the two further sections promised are to cover the inorganic compounds that remain and organic compounds.

One cannot but agree that this method of publication has its advantages for this sort of work, and one must bear with the disadvantages that are inevitable in loose-leaf publications. The pages tend, of course, to misalignment, although they are well clamped together by a simple device. Some instruction on the method of release of the covers would be valuable; X-ray crystallographers may be used to trial-and-error methods; but they do not wish to try them on their books.

The text is, on the whole, well written, although there are some phrases that ring strangely to the British ear: "non-rare gas shell atoms" is an awkward construction that cannot be improved by any ordinary method of hyphenating, and "fifth-column elements" has not the happiest of connotations. The author has also a tendency to use too few commas, as the following extract shows: "If as was done in Chapter II when discussing cobalt and the two forms of graphite layers in these three positions are designated as 0, 1 and 2, then . . ."; a comma after graphite is definitely required.

A technical difficulty, with which the author has unfortunately made no attempt to cope, is that due to the recent change in unit of measurement. Measurements are all given as in Angstrom units; but they are actually in kX. units. If it was not possible to correct all the dimensions given, a covering note explaining the difficulty should have been given; one hopes that such a note will appear in the further sections. But there is no doubt that difficulties will begin to appear when present structures, quoted in true Angstrom units, are included.

The book will inevitably be compared with the "Strukturbericht". Both works cover the same ground in much the same fashion, and it is in this respect that the author claims that the loose-leaf form of publication should have a decided advantage; it will enable all the data for a given material to be kept together, whereas with the "Strukturbericht" one has to look through all the volumes. It will be interesting to see how the experiment works in practice. Certainly all X-ray crystallographers will wish it well and will be grateful to Dr. Wyckoff for the large amount of time and effort that he has obviously spent in compiling the work. H. LIPSON

Chemical Architecture

Edited by R. E. Burk and Oliver Grummitt. (Frontiers in Chemistry, Vol. 5.) Pp. x+202. (New York and London: Interscience Publishers, Inc., 1948.) 4.50 dollars; 27*s*.

THE Western Reserve University in Cleveland, Ohio, has established a reputation for series of lectures in what is usefully termed the "Frontiers of Chemistry". These lectures deal with a variety of topics of current interest. In an expanded and therefore more acceptable form they have been published at intervals during the past few years. This is the fifth volume of the series. The need for reviews of this kind is perhaps more pressing than in normal times because few chemists have had the opportunity of writing monographs on those branches of chemistry in an active state of development.

Under the all-embracing title of this book many topics are discussed by a number of eminent chemists of the United States. In every case the lecture has been much expanded and fully documented, so that each article is an up-to-date and complete summary of the particular line of investigation. Dr. H. S. Taylor leads off with a generally discursive article on the influence of molecular geometry in reaction mechanism, particular attention being paid to heterogeneous reactions where molecular geometry is often of overriding importance. Dr. C. P. Smyth appropriately discusses the more recent contributions that dipole measurements have brought to the elucidation of the structure of a number of molecules in which the method is of particular value. There is a more than usually complete survey of the structure of co-ordination compounds by Dr. W. C. Fernelius. To go to the other extreme of difficulty, Dr. B. E. Warren deals with the important contribution X-ray diffraction studies have made to measuring the degree of disorder and of short-range order in substances like carbon black and certain alloys; and Dr. M. W. Tamele deals with the difficult problem of the structure of gels used as a substratum for the production of catalysts. The longest article, on "Light Scattering in Polymer Solutions", by Dr. H. Mark, is particularly opportune. There has been much talk and a great deal of experimenting with light scattering but not nearly enough published matter, theoretical or experimental. This article will be especially useful to all those interested in this important method.

H. W. MELVILLE

Pohledy do nebe

Problémy a výsledky moderní astronomie. Napsal Dr. Hubert Slouka. Pp. 460+43 plates. (Praha: Nakladatelství Orbis, 1947.) 165 Kčs. *In Czech.* (Exploring the Skies: problems and results of modern astronomy. By Dr. Hubert Slouka. Prague: Orbis, 1947.)

THIS recent astronomy book by the Czech astronomer, Dr. H. Slouka, aims at introducing a wide public to some of the most interesting astronomical problems of to-day. It is not intended as a text-book but rather to stimulate a more specialized study of its large variety of subjects. It falls into eight main chapters: the road to the stars; telescopes of to-day and to-morrow; the sun; the world of the planets; celestial wanderers; the world of the stars and nebulæ; beyond the Milky Way; and the birth and death of worlds. Tables of astronomical data are added as well as a useful bibliographical list. Many of the illustrations are drawings new to books of this kind; in addition, some forty plates are well chosen and beautifully reproduced. The first two editions of the book were published in Prague in 1942, and the author's remarks bear witness to the difficulties of the time in which he worked at it. The book is very vividly written in a manner which the author hopes will help "to win for astronomy new and enthusiastic friends who will strive for this most attractive of all sciences to penetrate to all sections of the public". A. B.

An Introduction to Mathematics

By Dr. A. N. Whitehead. (Home University Library of Modern Knowledge, No. 18.) Twelfth impression. Pp. v+192. (London: Oxford University Press, 1948). 5*s*. net.

THAT the late Prof. A. N. Whitehead's little volume should establish itself as a classic is not surprising. It was published in the "Home University Library" in 1911, was reprinted about eight times, and finally was reset in its present form in 1948 under the supervision of Prof. J. H. C. Whitehead, of Oxford, the late author's nephew. The diagrams have been re-drawn; but apart from the correction of inaccuracies and typographical errors, the author's original wording has, in no instance, been altered. In the reset edition the number of pages has been reduced from 256 to 191; but the text is still quite clear and readable. In seeking to explain the nature of mathematics, it still affords a very interesting account of how mathematics forms the background of all science.

Asparagus

By Alfred W. Kidner. Pp. 168+17 plates. (London: Faber and Faber, Ltd., 1947.) 15*s*. net.

THAT delectable vegetable, asparagus, has been cultivated by man for more than two thousand years; the elder Cato speaks of its cultivation, and it may be presumed that it was known and grown long before that time. Yet in all this long time it has changed little in its character, and, as the author of this book points out, no really fixed and distinct forms or varieties have been produced. It is strange that so esteemed a luxury should never have received much attention from plant-breeders. Largely through chance, Mr. A. W. Kidner took up the problem of selection and breeding of giant forms of asparagus, and through long years of empirical observation, isolation and cross-fertilization developed strains of superlative quality. There is no doubt of the success that has attended his efforts, and they show what might still be done if the genetics of the plant were really worked out and strains homozygous for the desirable qualities fixed.

The author lays no claim to being a man of science, and throughout the work there runs a curious implication almost of surprise that asparagus should respond to controlled breeding methods—a suggestion of pleading a case that special laws operate in this one instance and that it may be difficult to convince the reader of the value of breeding. In this respect, the book is needlessly repetitive; but, as an otherwise straightforward account of how the practical man can go about developing his own super-quality strains and how to grow and market them, the book is of great value. It should certainly stimulate the new National Vegetable Research Station, when it begins operations, to take up the study of the genetics of asparagus. R. H. STOUGHTON

SOME RECENT ADVANCES IN RADIOCHEMISTRY*

By Prof. H. J. EMELÉUS, F.R.S.

IN the decade since the discovery of atomic fission by Hahn and Strassmann, the subject of radiochemistry has undergone rapid development. It has always been in the background of all the major advances in radioactivity, and the very magnitude of these advances in recent years has resulted in the presentation to the chemist of a wide range of new problems. Three of these will be discussed briefly here. The first, the chemical separation of the fission products of uranium and other fissile elements, is largely a matter of chemical analysis and differs from more familiar analytical problems only in complexity and in the fact that microchemical techniques are used. The second problem, that of fitting the many new radioactive isotopes of the heavy elements into modifications of the classical decay series, has been solved by a combination of the physical and the chemical methods of approach. The third major problem is the study of the chemistry of the new transuranic elements neptunium, plutonium, americium and curium, as well as of those of atomic numbers 87 (francium), 85 (astatine), 61 (illinium or prometheum) and 43 (masurium or technetium), which probably have not been isolated from natural sources but are now available, in small amounts, in the form of radioactive isotopes formed by suitable nuclear transformations.

Fission Products

The isotopes which are known to undergo fission with slow neutrons are uranium-233, uranium-235 and plutonium-239; others (thorium-232, ionium-230, protoactinium-231, uranium-238 and neptunium-237) require fast neutrons, and less information is available on the fission products†. In the fission of uranium-235 by slow neutrons, to take an example, two lighter nuclei are formed in each fission. The following is a typical equation:

$$U_{92}^{235} + n_0^1 = Kr_{36}^{92} + Ba_{56}^{141} + 3n_0^1 + 175 \text{ Mev.}$$

The nuclei formed fall into two groups, a light and a heavy, the most abundant members of which are in the ranges $Z = 35$ to 43 (bromine to technetium) and $Z = 51$ to 58 (antimony to cerium), other less abundant nuclei falling between and outside these two ranges. The fission products have masses greater than those of the heaviest natural stable isotopes of the elements in question. In the case of the krypton and barium isotopes mentioned above, for example, the heaviest stable isotopes have masses of 86 and 138 respectively, and the fission fragments are β-active, which reduces the mass to charge ratio of the nucleus to a stable value. This gives rise to fission decay chains of which the accompanying are typical.

$$Kr_{36}^{92} \xrightarrow[\beta]{3s.} Rb_{37}^{92} \xrightarrow[\beta]{\text{short}} Sr_{38}^{92} \xrightarrow[\beta]{2{\cdot}7h.} Y_{39}^{92} \xrightarrow[\beta]{3{\cdot}5h.} Sr_{40}^{92} \text{ (stable)};$$

$$Xe_{54}^{141} \xrightarrow[\beta]{3s.} Cs_{55}^{141} \xrightarrow[\beta]{\text{short}} Ba_{56}^{141} \xrightarrow[\beta]{18min.} La_{57}^{141} \xrightarrow[\beta]{3{\cdot}7h.} Ce_{58}^{141} \xrightarrow[\beta]{28d.} Pr_{59}^{141} \text{ (stable).}$$

In such chains it is possible for an intermediate member to be formed directly by fission, but in general the chance of this happening becomes less as the stable end is approached. The mass number in the chain is constant, and determinations of fission yield are generally made with reference to this mass number rather than to any particular element. The fission yield is defined as the percentage of all fissions for a given range of neutron energy yielding nuclei of a particular mass number, and its determination calls for methods of analysing the fission products chemically and also for a correlation between the number of fissions and the amount of each mass formed.

In the chemical analysis of fission products, carriers and so-called hold-back carriers are used. The need for a carrier arises from the exceedingly small absolute weights of radioactive material present in the mixture. In separating a particular element, a small amount (1–10 mgm.) of inactive isotopic material is added, which renders manipulation on the micro scale possible. Inactive hold-back carriers are used in similar amounts to minimize radioactive contamination of the element sought by other fission products, which would otherwise be carried down in precipitation reactions. The hold-back carriers do not eliminate this contamination, but they ensure that when it occurs it involves largely the inactive atoms of the hold-back carriers and not the isotopic fission products.

Material for the chemical separation of fission products is now obtained readily by the irradiation of uranium or one of its compounds in the atomic pile. In the early work on fission other neutron sources, such as a radium–beryllium mixture, were used. The following are typical of the many methods of chemical separation employed, carriers and hold-back carriers being used in most cases.

(1) Separation of barium and strontium as nitrates by precipitation with fuming nitric acid, followed by precipitation of barium as chromate and strontium as sulphate.

(2) Direct removal of the rare gases krypton and xenon, followed by the mass spectrographic determination of the various isotopes.

(3) Precipitation of sulphides of arsenic, germanium, selenium, tellurium, molybdenum, antimony, technetium, rhodium and palladium with hydrogen sulphide in acid solution, followed by further separation of the individual elements.

(4) Separation of the rare earths by ion exchange resins.

Following the separation of each element, it is essential to study, and if necessary analyse, the decay characteristics of the product, which may contain several isotopes. Further chemical separation of a daughter element formed in the decay of that isolated is also carried out in many cases, in addition to which the activities observed are identified when possible with those due to isotopes formed in unambiguous nuclear reactions brought about, for example, with the aid of the cyclotron. The information so gained has been fitted together gradually to give a fairly complete picture of all the fission products and their decay chains.

* Based on a course of three lectures delivered at the Royal Institution on March 15, 22 and 29.

† The information contained in this article is drawn largely from declassified reports issued by the United States Atomic Energy Commission, the Division of Atomic Energy of the National Research Council and the Division of Atomic Energy of the Ministry of Supply.

In the atomic pile, the amount of each fission product grows to a constant value at which its rate of formation equals its rate of decay. This makes possible the direct comparison of the relative yields of various fission products from observations made on the activity of materials from the chemical separation, provided the observed activities are corrected for decay during the chemical separation, and also for the fact that irradiation in the pile may not have been long enough for the activity to grow to its saturation value. Other corrections for factors inherent in the counting of β-particles of different energies may also be necessary. To transform these relative values to absolute values, it is necessary to determine absolutely the fission yield of some one isotope. The 12·8-day isotope barium-140 has been much used as a standard, because of its convenient life and ease of separation. If Y_R and Y_S are the yields of two fission products R and S, and D_R^∞ and D_S^∞ the respective saturation disintegration-rates, then $Y_R/Y_S = D_R^\infty/D_S^\infty$.

In determining the absolute fission yield of the standard substance, the essential experiment is to mount a very small weighed sample of a uranium compound in a fission-counting chamber in the thermal column of the atomic pile, and to place in the same neutron flux a larger known sample (for example, 0·1 gm.) of the uranium compound for subsequent chemical analysis. A known weight of carrier is used in the analysis, and the actual weight of this carrier recovered is measured. It carries with it a proportionate amount of the total activity of the standard fission product. Fission-yield curves obtained by the procedure outlined have now been published for uranium-233, uranium-235 and plutonium-239, and they show a great similarity, apart from small displacements in mass due to the different masses of the fissile nuclei.

The New Radioactive Decay Series

The second major radiochemical problem, the place of the transuranic elements in the decay series, has had as its most striking result the discovery of a new series, the neptunium or $(4n + 1)$ series, the longest lived member of which is the isotope Np^{237}_{93}. There are, in addition, a number of new branches and extensions of the classical series into which isotopes of elements 93, 94, 95 and 96 have been fitted. The decay scheme of the neptunium series, none of the members of which are known to occur in Nature, is shown above.

The study of the greater part of this series, isolated members of which have been known for some time, has followed from the isolation of uranium-233 in moderate amounts from thorium irradiated in the atomic pile, where it undergoes an (n, γ) reaction followed by two successive β-decays. The radium isotope is separated chemically from the uranium-233 solution, using a barium carrier, and is then found to grow an activity due to an actinium isotope, which is separated with a lanthanum fluoride carrier. This established the β-activity of the radium isotope. The actinium isotope shows four α-activities, the energies of which are studied with the pulse analyser. Of these one, due to the alkali metal francium, may be separated chemically with cæsium perchlorate. The isotope bismuth-213 is separated with a bismuth carrier, and the isotope lead-209 is identified, when it has grown in the actinium solution, by using a lead carrier. This particular activity has been produced by several independent nuclear reactions and the isotopic assignment is clear. There is little direct chemical evidence for the isotopes astatine-217, polonium-213 and thallium-209, and in these cases identification depends largely on physical methods.

The above gives only a general indication of the chemical approach to a problem of this type. Other similar series of radioactive isotopes have been produced by the use of the cyclotron, particularly at the University of California, where so many of these new developments have originated. As an example of the production of a series of synthetic isotopes which form a branch to one of the main decay series, work on the protoactinium series may be mentioned. The parent isotope, protoactinium-230, is formed in the deuteron or helium ion bombardment of thorium and decays according to the following scheme, the last member shown, radium C′-214, being a member of the classical uranium–radium series.

$$Pa^{230}_{91} \xrightarrow[\beta]{17d.} U^{230}_{92} \xrightarrow[\alpha]{20{\cdot}8d.} Th^{226}_{90} \xrightarrow[\alpha]{30{\cdot}9m.} Ra^{222}_{88} \xrightarrow[\alpha]{38s.} Em^{218}_{86} \xrightarrow[\alpha]{0{\cdot}019s.} RaC'^{214}.$$

The Actinides

Chemically, the new elements neptunium, plutonium, americium and curium are believed to form part of a new series, known as the actinides, analogous in the arrangement of their extra-nuclear electrons to the rare earths (the lanthanides). Starting probably with thorium, successive elements gain an electron in the 5*f*-shell, which in the case of curium contains seven electrons and is half full (just as the 4*f*-shell is half full in gadolinium). The physical evidence for this hypothesis is far from complete: some indication is given by optical and X-ray spectra and by magnetic measurements, while some of the actinide ions in solution have sharp absorption bands, which would be expected if transitions occurred in a shielded inner shell. X-ray studies of a number of compounds of the actinides have also been made and show a contraction in ion size as the series is ascended, which is similar to the lanthanide contraction for the rare earth ions. This is seen in Table 1, where the lanthanide contraction is also illustrated.

Table 1. Crystal radii of actinide and lanthanide ions

No. of *f*-electrons	Crystal radii of ions (A.)					
	Thoride series		Actinide series		Lanthanide series	
0	Th^{4+}	0·95	Ac^{3+}	1·11	La^{3+}	1·04
1	Pa^{4+}	(0·91)	$(Th^{3+}$	1·08)	Ce^{3+}	1·02
2	U^{4+}	0·89	$(Pa^{3+}$	1·06)	Pr^{3+}	1·00
3	Np^{4+}	0·88	U^{3+}	1·04	Nd^{3+}	0·99
4	Pu^{4+}	0·86	Np^{3+}	1·02		
5	Am^{4+}	0·85	Pu^{3+}	1·01	Sm^{3+}	0·97
6			Am^{3+}	1·00	Eu^{3+}	0·97

The valencies of the actinide elements are shown in Table 2, together with those of the corresponding rare earths.

Table 2. Valencies of the actinides and lanthanides

Element	Valencies	Element	Valencies
Ac	3	La	3
Th	4, (3), (2)	Ce	4, 3
Pa	5, 4	Pr	5, 4, 3
U	6, 5, 4, 3	Nd	(4), 3
Np	6, 5, 4, 3	Tc	3
Pu	6, 5, 4, 3	Sm	3, 2
Am	4 or 5, 3, 2	Eu	3, 2
Cm	3	Gd	3

Values are in some cases higher than for the rare earths, which reflects the looser binding of the 5*f*-electrons and their more ready promotion to the valency shell. Between uranium and curium there is an increase in stability of the lower valency states, and it is remarkable that americium can be reduced by sodium amalgam to the bivalent state, which resembles the corresponding states of samarium and europium. Both americium and curium resemble the rare earths rather closely, and are best separated from them by the use of ion exchange resins. Numerous compounds of the new actinide elements, and of plutonium in particular, have now been described, and, although their radioactivity and the resulting need for special facilities may render them inaccessible to most laboratories, the chemistry of these substances will undoubtedly shortly be as well known as that of most other elements.

Much less has been published as yet on the chemistry of francium, astatine, prometheum and technetium, the other four new elements mentioned earlier. Astatine in the form of the isotope At_{85}^{211}, an α-active substance of 7·5-hr. half-life, has, however, been used in tracer studies which have given a general picture of its chemistry. The element itself may be extracted from solution with organic solvents and thus resembles iodine. There is also definite evidence from ion migration experiments that it can form negative ions, which are probably analogous to the iodide and iodate ions. The intense α-activity of astatine will, however, render the study of its chemistry on anything approaching a macro scale a matter of very great difficulty. The missing rare-earth element of atomic number 61 has now been clearly identified by its X-ray emission spectrum. It is formed in fission and also in cyclotron reactions, and has been separated with the aid of ion exchange resins. There is, however, no reason to expect that the chemistry of the element will differ substantially from that of the other rare earths. In the case of technetium, at least milligram quantities of one of the long-lived radioactive isotopes have already been prepared, and, in view of its position between manganese and rhenium in the periodic table, the element and its compounds are likely to be of very great interest to the chemist.

BIOCHEMICAL ASPECTS OF GENETICS

IT was often emphasized by the late Sir Frederick Gowland Hopkins that a study of the individual cell and of the organisation of chemical reactions within the cell was the true objective of biochemistry. The relationship of genetic constitution to chemical activity is, in such a connexion, a matter of first importance; but it was not until some ten years ago that investigations of this nature could be applied experimentally to unicellular organisms. Following a proper advance in technique, derived largely from the work of Beadle and Tatum, corresponding advances have taken place in the elucidation of genetico-biochemical problems.

The symposium organised recently by the Biochemical Society upon "Biochemical Aspects of Genetics" would have delighted Hopkins, for he was convinced that in this direction lay the biochemistry of the future. Sufficient indication was available from the pioneer work of such investigators as Garrod and Onslow on multicellular organisms that there awaited a rich harvest to be gathered in the fullness of time, and the discussion here reported has further endorsed such an expectation.

The symposium was so organised that in the morning session, under the chairmanship of Prof. J. B. S. Haldane, the development was reviewed of our knowledge of colour inheritance and pigment production in flowers and the interpretation of chemical abnormalities encountered in man. The afternoon session, under Dr. A. Neuberger, dealt with chemical methods of inducing mutation, the relation between gene action and mutation, between spatial pattern as the geneticist understands it and the time sequences of biochemical processes, and finally with the problem of the relationship existing between genetic differences and the production of adaptive enzymes in micro-organisms. A wide field was thus covered, which served to point to problems for future resolution as well as frequently to indicate striking identity of conclusion by workers in the biochemical and genetical laboratory respectively.

That a simple relation must exist between genes and enzymes is, of course, an assumption essential to all this work on biochemical genetics; but the exact form of such relationship has still to be determined —whether, for example, one particular gene controls the elaboration of one particular enzyme, or whether the gene itself may not, indeed, be identified with the enzyme in question. The bulk of experimental and clinical evidence is in favour of the former one-to-one hypothesis; but it seems that the question of identity, or otherwise, may not be finally answerable until we know much more concerning the nature of adaptive enzymes and the mechanism of their formation.

Considering now in more detail each of the contributions to this symposium, W. J. C. Lawrence described how Onslow's suggestion that in *Antirrhinum majus* anthocyanins were derived from anthoxanthins led to the later investigations at the John Innes Institution which demonstrated that anthocyanin production was controlled as regards amount, state of oxidation, degree of methylation and glucosidal type by simple gene relationships, as were also flavone and chalkone production. Further, it was shown that in *Dahlia*, competition could exist between the production of anthocyanin, flavone and

chalkone, according to gene dosage, implying the parallel production of these materials from a common precursor, a view which had previously been put forward on purely theoretical grounds by Robinson.

Prof. L. S. Penrose set forth Garrod's fundamental conception of certain disease states or metabolic anomalies as inborn errors of metabolism, and showed how such an analysis enabled an explanation to be given for the first time by Garrod of the special significance of inbreeding in man.

Prof. C. Rimington pointed out that Garrod's interpretation of familial conditions as being due to the lack of a particular enzyme essential for the completion of a certain stage in normal intermediary metabolism is probably correct in the case of alcaptonuria, and cited good evidence for believing tyrosinosis and phenylketonuria to be similarly interpretable. In familial methæmoglobinæmia, deficiency of a co-enzyme factor in the erythrocytes of affected persons has actually been demonstrated by Gibson. Certain of the conditions studied by Garrod, notably cystinuria, are better interpreted, however, as errors of retention or excretion. Thus cystine is only one of a group of substances showing some chemical similarity which are demonstrable in cystinuric urine, and it would appear that in this condition the kidney is unable to re-absorb certain constituents from the glomerular filtrate. A precisely similar explanation has been given by Friedman and Byers for the excretion of uric acid by the Dalmatian dog, and these workers produce compelling experimental evidence in support of their view.

The different classes of substance which are available for the chemical induction of mutation—mustards, carcinogenetic hydrocarbons, etc.—were discussed by Dr. J. G. Carr, who pointed out that all are radiomimetic. As yet no substances have been discovered which will react with only one gene.

Dr. D. G. Catcheside analysed the relationship between gene action and mutation. Some extreme mutations, in which loss of activity appears to be complete under all conditions within which the organism is viable, can back-mutate or revert to the wild type. This must mean that an almost intact gene, capable of reproduction, must have persisted. The most probable postulate is that specificity has been retained, but that the enzyme produced by the mutant gene suffers from a restricted stability, for example, as regards temperature or *p*H. In other cases back-mutations never occur.

Dr. G. Pontecorvo, after describing the modern techniques for the genetical study of moulds, bacteria, protozoa, etc., posed the question whether or not spectral organisation of genetical architecture is related to the time sequence of biochemical steps it controlled, in some such way as are operations along assembly lines. There is some suggestion that this may be so, but further specifically planned investigation is needed to prove this point.

In the concluding contribution, Dr. J. Monod dealt with the phenomenon of adaptation encountered in bacteria, and showed how, for example, in *E. coli* ML, a lactose-splitting enzyme, lactase, and a maltose-splitting enzyme, amylomaltase, may be induced to form within the cells by cultivating them upon the respective substrates. The same two enzymes are subject to genetic control, as is seen from spontaneous and induced mutations. These latter are independent of the state of adaptation of the cells.

It is clear that much remains to be done before such fundamental processes of the cell as those under discussion at this symposium are fully understood, but that already biochemistry and genetics have joined in a partnership from which both are bound to profit immeasurably. C. RIMINGTON

THREE HISTORICAL NOTES

By Dr. D. McKIE
University College, London

Boyle's Library

THE Hon. Robert Boyle died on December 30, 1691, and some curiosity has been expressed from time to time in recent years about what was done with his books after his death. In that valuable bibliographical study of Boyle that has made every student of seventeenth-century science his debtor, Prof. John Fulton quoted an entry for April 1, 1692, from a diary, now in the Bodleian and possibly by Zachary Merrill, to the effect that Boyle's library contained "330 fol. 801 qtos. 2440 Oct and 12. most of y^{m} well bound. They may be had for 3 or 400£ (tho' worth 1000) because they must not be sold by Auction"[1]. It was a considerable collection. Later, Fulton quoted[2] a further reference through the discovery by Mr. J. C. Hindle, of the Bodleian, of an advertisement dated July 9, [1692], stating that: "The Library of the Honourable Robert Boyle, Esq; lately Deceased, will be sold by Retail, on *Monday* the 11*th*. of this Instant *July*: Any Gentlemen or Others, may have the opportunity to View, and Buy what they please, at reasonable Rates. Attendance will be given at the late Lady *Ranelaugh's* House in the *Pell-Mell*, near St. *James's*, on *Monday*, *Tuesday* and *Thursday* next, from Nine a Clock in the Morning till Seven at Night." In explanation of the reference to "Pell-Mell", it is known that Boyle lived with his sister, Lady Ranelagh, in her house in Pall Mall; she predeceased him by a week.

From this announcement, says Fulton, the library was not sold until July 1692, and then not by auction, but privately. It would seem, therefore, that booksellers and others were invited to buy from the collection lots or items in which they were interested.

Recently a copy of Becher's "Novum Organum Philologicum" (Francofurti ad Mœnum, 1674) came into my hands with the inscription on the reverse of the fly-leaf, "R. Hooke p^{d} 21^{d}. Mar.25.1693MF.", since verified as being in Hooke's handwriting. Reference to the fragment of Hooke's diary for 1688–93 confirmed the details of the inscription; for under that date he had recorded, "In MF Paid 1.9d for Bechers *Novum Organum philologicum*"[3]. Further reference to the diary for the same period brought to light a number of other interesting entries which indicate that Boyle's library was dispersed.

Two days before he bought Becher's book, Hooke "in MF saw many of Mr Boyles German chemicall books, also Bechers word-book"[4], which suggests that this copy of Becher's book may well have belonged to Boyle before Hooke, since Becher was a well-known writer on chemistry and since it was a scientific book, a kind of thesaurus of scientific terms in Latin and German. Boyle did not, so far as is known, have a book-plate and he did not inscribe his name in his books.

Four days previously, on March 21, 1693, Hooke wrote: "In MF I saw neer 100 of Mr Boyles high Dutch German Chymicall books ly exposed in Moorfeilds on the railes . . ."[5]. It seems, therefore, that some at least of Boyle's books were sold to a bookseller in Moorfields. Later, at Tom's coffee-house, Hooke, on March 28, 1693, "Read a *Catal.* of Morgans and Boyles books at Toms"[6]. Next day, he called at Tom's for a catalogue "for Mr Waller".

These entries by Hooke make it practically certain that Boyle's library was dispersed and that there is no hope of its now being recovered, as Newton's was.

The Descent of Pierre Joseph Macquer (1718-84)

Pierre Joseph Macquer (1718–84), compiler of the first dictionary of chemistry and professor of chemistry in the Jardin du Roi, is said to have been descended from a noble Scots family who had lost all for the Stuart cause and the Catholic faith. Macquer does not, however, seem to be a corruption of a Scots name; even if it were derived from Ker, the noble families of that name were not supporters of the Stuart cause[7]. It appears that Macquer's family came to France, not after the rising of 1715, but with James II in 1689[8]. This would suggest the possibility of an Irish origin.

Search in the parish registers of St. Germain-en-Laye, the refuge of James II and his Court, reveals the name of Maguire, the family name of Lord Enniskillen, and in various spellings such as Magoire, Mackower, Magower, Makaire, Magaire and other forms, as well, of course, as the correct one[9]. In most cases the entries relate to members of the ill-fated house of Enniskillen. The peerage had been forfeited in 1645, when Connor, second baron, was hanged at Tyburn for his share in the rebellion (1641) of Owen Roe O'Neill. The family continued to use the title, and Roger, fifth baron, was appointed Lord Lieutenant of Fermanagh by James II in 1689.

The curious varieties of spelling in the registers of St. Germain leave no doubt of the possibility of the corruption of Maguire to Makaire. French pronunciation would make no difficulty in corrupting Maguire to Macquer. In fact, the Irish officer, Richard McGuire, who was associated with Richard Crosbie (1755–1800), the first Irish aeronaut, is described by Tissandier as "un jeune aéronaute nommé Quer"[10].

The established corruption in spelling and the descent from a noble family suggest, therefore, that Macquer may have been a descendant of the Maguires, Barons of Enniskillen, and of Irish, rather than Scots, origins.

Sir Thomas Browne and Biringuccio's "Pirotechnia"

The recent publication of a complete English version of the "Pirotechnia" (1540) of Biringuccio[11] has once again raised the question of the currency of this work in earlier times, and the alleged preference for the "De Re Metallica" (1556) of Agricola. The translators directed attention[12] to an entry in Hooke's diary for November 12, 1675[13], referring to Biringuccio's treatise, but pointed out that known references to this great book are few. Another is, however, to be found in Hooke's diary under the date March 1, 1677/8, when Hooke acquired a copy for two shillings[13]. Attention is also directed to a further reference by Sir Thomas Browne in his "Hydriotaphia" (1658)[14], where he refers to the preservation of charcoal underground for more than four hundred years as described by Biringuccio[15].

[1] Fulton, J. F., "A Bibliography of the Honourable Robert Boyle . . ." (Oxford, 1932), reprinted from the *Proceedings and Papers of the Oxford Bibliographical Society*, **3**, pt. 1, 4.
[2] Addenda to a Bibliography of the Honourable Robert Boyle, 2–8 (Oxford, 1933) (reprinted from *ibid.*, **3**, pt. 3).
[3] Gunther, R. T., "Early Science in Oxford" (Oxford, 1935), **10**, 223. MF = Moorfields.
[4] *ibid.*, 224.
[5] *ibid.*, 223.
[6] *ibid.*, 225–26.
[7] Thomson, Thomas, "The History of Chemistry", **1**, 295 (London, 1830).
[8] "Nouvelle Biographie Générale, **32**, 595 (Paris, 1860).
[9] "The Parochial Registers of Saint Germain-en-Laye. Jacobite Extracts of Births, Marriages and Deaths", ed. C. E. Lart, **1**, 4, 21, 25, 53, 93, 94, 108, 109, 139, 158, and **2**, 16, 22, 23, 35, 67, 73, 82, 93, 102, 107, 163 (London, 2 vols., 1910–12).
[10] Tissandier, G., "Histoire des Ballons et des Aéronautes Célèbres, 1783–1890", **1**, 103 (Paris, 2 vols., 1887–90).
[11] "The Pirotechnia of Vannoccio Biringuccio . . .", trans. C. S. Smith and M. T. Gnudi (New York, 1943).
[12] *ibid.*, p. xvii. See also "The Diary of Robert Hooke . . . 1672–1680", ed. H. W. Robinson and W. Adams, 193 (London, 1935).
[13] "Diary", 347.
[14] "Hydriotaphia, Urne-Buriall, etc.", 36 (London, 1658). "The Religio Medici and other Writings" (Everyman ed.), 113.
[15] "Pirotechnia" (English trans.), 177.

OBITUARIES

Prof. C. H. Lander, C.B.E.

Cecil Howard Lander was born at Stockport, Cheshire, in 1881. After receiving his early education at private schools in Cheshire, he decided to prepare for engineering as his career. His first step was to obtain practical training. To this end, on leaving school, he joined the engineering staff of the Manchester Ship Canal Company, then moved to become an assistant to the late Mr. Charles Hopkinson, and eventually was on the staff of Heenan and Froude, by whom he was employed on the design and testing of refuse destructors. In consequence, Lander had acquired a background of varied practical experience over about five years before he entered the University of Manchester in 1902 as a student in engineering. At the University his ability was soon recognized. He graduated in 1905 with first-class honours and was awarded the Fairbairn Prize.

On graduation, Lander continued as a research student. A year later he was appointed a demonstrator, and in 1910 was promoted to a lectureship in engineering in the University of Manchester, a post which he held until he joined the R.N.V.R. in 1916. Lander's research work while he was in Manchester included a series of investigations on problems of heat flow, surface friction and allied phenomena, on the results of which he was awarded the degree of M.Sc. in 1908 and D.Sc. in 1916. During this period he was also a part-time engineer to the Home Office in charge of experimental work on heating and ventilation for the Humidity Committees; this work was the basis of regulations since included in the Factory Acts.

During 1916–20 Lander served as a lieutenant in the R.N.V.R., and his important work in relation to several war-time requirements was recognized by an award on the recommendation of the Royal Commission on Awards to Inventors. On leaving the R.N.V.R. in 1920, Lander was appointed assistant to the director of fuel research (the late Sir George Beilby) in the newly established fuel research organisation of the Department of Scientific and Industrial

Research. Two years later he was promoted to the post of deputy director and in 1923, on the retirement of Sir George Beilby, he became director of fuel research, a post which he held until 1931. Under his guidance the fuel research organisation undertook important investigations on the carbonization and gasification of coal and coke, on the production of oil from coal by hydrogenation, and on many other fuel problems. In association with the late Dr. F. S. Sinnatt, he organised and developed the Physical and Chemical Survey of the National Coal Resources. In recognition of his work as director of fuel research, Lander was made a C.B.E. in 1928.

In 1931 Lander returned to academic life as professor of mechanical engineering at the Imperial College of Science and Technology, London, a post which he held with distinction until 1946. Under his guidance, based on his broad experience and deep interest in education, a high standard in the training of mechanical engineers was achieved. He also played a prominent part in the systematic training of chemical engineers, and was the first chairman of the Board of Studies in Chemical Engineering in the University of London. The branch of research in which he was most keenly interested was that in relation to problems of heat transfer, on which he led and inspired teams of investigators for more than twenty-five years. His notable papers on the subject included that which he presented to the Institution of Mechanical Engineers in 1942, and for which he was awarded the Hawksley Gold Medal and Premium.

During the Second World War, Lander's experience and ability were invaluable. He played a great part in the development of gas turbines and jet propulsion, flame-throwers, and oil burners (F.I.D.O.) for the dispersion of fog over airfields. His merit in this kind of work lay not only in the way he guided and inspired investigators under his immediate control, but also in the facility with which he co-ordinated the work of several teams under different leaders and ensured harmonious co-operation from all in achieving results rapidly.

Of the many organisations indebted to him for advice and help, only a few can be mentioned as examples. He was for many years vice-chairman of the British National Committee of the World Power Conference, a member of the Safety in Mines Research Board, a member of the Mechanical Engineering Research Board of the Department of Scientific and Industrial Research, and chairman of several war-time scientific committees. For two years, 1946–48, he was president of the Institute of Fuel and was awarded the Melchett Medal of that Institute in 1945.

On retiring from the professorship of mechanical engineering at the Imperial College in 1946, he accepted an invitation to become dean of the Military College of Science at Shrivenham, with the task of re-organising the College as the principal establishment for training army officers in the military applications of science and technology. In this new sphere of activity, Lander had already achieved notable success. It was while he was engaged on this work that Lander died suddenly at Shrivenham on March 17.

Apart from his professional work, Lander had other interests, including music; and he had looked forward to spending more time at his house at Shepperton and with his motor launch on the Thames. Of a kindly nature, he will be missed by his many friends and colleagues.

A. PARKER

In October 1946, Dr. Lander became dean of the Military College of Science, which was re-assembling after the War at Shrivenham in Wiltshire and was expanding its scope to prepare officer students for external degrees in science and engineering of the University of London as well as to train officers for the technical staff of the Army.

The re-organisation necessary to enable the College to carry out these extended functions at the same time as it was being reconstituted involved an enormous amount of work in the remoulding of the faculties, in discussions with the University of London, in the preparation of syllabuses and in the recruitment of lecturing staff. The co-ordination of this work in the College fell upon Dr. Lander, and his energy and enthusiasm and his connexions with the University contributed in great degree to the reconstitution of the College. That within two and a half years of its re-opening the first technical staff course passed out and the first degree courses took Part I of their degrees at London was largely due to his untiring work.

His wide contacts with the academic world resulted in the best of advice being available to the College, and his strong support of a policy of insistence upon high academic standard has laid sound foundations for the future.

Apart from his work on the academic side, Dr. Lander was a keen supporter of the sports and cultural activities of the College. He was a leading performer in the Musical Club and led the College orchestra.

But the quality by which he will be most remembered in the College was his kindly wisdom. In an assembly of soldier students and of academic and soldier teachers, most problems are viewed from several points of view and divergent opinions are strongly held. That varying opinions have been reconciled and canalized into channels which furthered the objects of the College has been in no small degree due to Dr. Lander's unfailing wisdom. His counsel both in wider policy and in day-to-day detail was invaluable, and the Military College of Science will look back on its first dean, with feelings of gratitude and deep affection, as one of the main founders of its modern constitution.

W. J. ELDRIDGE

Mr. H. E. Hadley

MR. H. E. HADLEY, well known as the author of many elementary text-books of physics, died on March 6, at the age of eighty-two. Mr. Hadley had lived rather a retired life. He was appointed headmaster of a small science school in Kidderminster, where he combined with physics a lectureship in chemistry. In those days, physics was considered of less importance than chemistry; but Mr. Hadley was always at heart a physicist. In spite of the almost total lack of physical apparatus, he made physics the career of three of his early pupils, for in three successive years his students gained national scholarships at the Royal College of Science, London, now the Imperial College of Science and Technology, a rather unique success for a small school.

Mr. Hadley was a contemporary of Sir Richard Gregory and H. G. Wells at the same College, and from his training there and association with C. V. Boys he acquired a special genius for making his own physical apparatus. His teaching equipment at Kidderminster was largely of his own making,

and it would seem that this gave physics an added attraction to his students. Evidence of his ingenuity in this direction is apparent in his books.

In 1898 he wrote his first text-book, on "Magnetism and Electricity for Beginners". This was the first of several text-books produced in association with Sir Richard Gregory, which are known to generations of physics students. Much of his time thenceforward was devoted to the preparation of these books, while he still continued his teaching, from which he only recently retired after a period of more than fifty years. He maintained his interest in his books to the end, devoting much care to keeping them abreast of modern developments.

Mr. Hadley had a charming personality, and he was regarded with affection by those who benefited from his instruction. W. S. TUCKER

WE regret to announce the following deaths:

Mr. Will Hay, well known as an actor and also a distinguished amateur astronomer, on April 18, aged sixty.

Mr. R. A. Todd, a Ministry of Agriculture and Fisheries inspector and formerly a member of the staff of the Plymouth Laboratory of the Marine Biological Association of the United Kingdom.

NEWS and VIEWS

Meldola Medal for 1948: Dr. R. A. Raphael

ON the recommendation of the Council of the Royal Institute of Chemistry, the Society of Maccabæans has awarded the Meldola Medal for 1948 to Dr. Ralph Alexander Raphael, in recognition of the contributions he has made to the investigation of new methods of approach to the synthesis of natural compounds. Dr. Raphael graduated in 1941 from the Imperial College of Science and Technology with first-class honours in chemistry, and in 1943 was awarded a Ph.D. for work on acetylenic compounds. During 1943–46 he was head of one of the chemotherapeutic research departments of Messrs. May and Baker, Ltd., and was mainly concerned with penicillin chemistry. He was then awarded an Imperial Chemical Industries fellowship and resumed research work at the Imperial College on the investigation of the potentialities of acetylenic compounds in the synthesis of natural products. In 1947 this work resulted in the total synthesis of the penicillic acid, thus proving its structure beyond doubt. Attention was then turned to the utilization of the peculiar properties of acetylenic compounds to accomplish the synthesis of carbohydrates and their derivatives, and, up to the present, arabitol, ribitol, erythritol, threitol and erythrulose have been obtained. A study is also being made of methods of producing long-chain aliphatic acids of various types. Concurrently, Dr. Raphael is also investigating synthetic routes to compounds containing the vitamin D triene system. He has recently been appointed lecturer in organic chemistry in the University of Glasgow.

Avenue of Human-headed Sphinxes at Luxor

IT has long been known that the avenue of ram-headed sphinxes of Amenophis III which extends southwards from the Temple of Khons at Karnak is the northern end of a processional way once linking the Temple of Karnak with the Temple of Luxor about one and a half miles to the south. On the line of this avenue, Zakaria Effendi Ghoneim, chief inspector of antiquities for Upper Egypt, has recently found a further series of human-headed sphinxes erected by either Nectanebo I or II about a thousand years later, in the late fourth century B.C. The main interest of the new discovery appears to lie, for the moment at least, in the inscriptions on the base of each sphinx. The text records that Nectanebo had "made this road for Amun so that he might make good navigation from Luxor". The god Amun was normally resident at Karnak. The principal occasion on which he visited Luxor was during the annual festival of Opet, when he was conveyed by river from Karnak to Luxor and the whole city was given over to festivity for many days. The new texts, therefore, either hint that by the end of the Pharaonic period the river journey of Amun during the Feast of Opet had been replaced by a progress by land, or they refer to a new or unidentified Theban feast. As the clearance and excavations round the Temple of Luxor progress, there is every reason to expect that new discoveries will be made, and that fresh light will be thrown on the early history of Thebes.

Additional Remains of *Australopithecus* in South Africa

FURTHER discoveries of the remains of the fossil Australopithecinæ of South Africa are now reported from a new site, Makapansgat, almost 250 miles north of Sterkfontein, where Dr. R. Broom found numbers of skulls and portions of the limb skeleton during 1947 and 1948. Two of the Makapansgat specimens, which have already been described by Prof. R. Dart in the *American Journal of Physical Anthropology* (**6**, 259 and 391; 1948) and referred by him to a new species, *A. prometheus*, consist of an occipital bone and an immature mandible. These provide additional confirmation of the inferences based on the earlier material that the Australopithecinæ show in certain anatomical features a remarkable approximation to those hitherto regarded as distinctive of the Hominidæ. For example, the disposition and extent of the nuchal crest and muscular markings on the occipital bone conform to the human rather than the simian type. The perfectly preserved and unworn anterior premolar in the immature mandible is bicuspid with the cusps of approximately equal height as in man, and thus differs markedly from the characteristic sectorial form of the lower anterior premolar in the anthropoid apes. Still more recently, there have been found at the same site a considerable part of the facial skeleton, a parietal bone, and the iliac portion of a pelvis. According to unpublished reports, the ilium, like the specimen already described by Broom (*Nature*, **160**, 430; 1947), is closely similar in shape and proportions to a human ilium, and thus contrasts strongly with that of apes.

Science Museum, London

DEMOLITION of the old portion of the Science Museum, London, known as the Southern Galleries,

has now commenced. This building, which had recently become extremely dilapidated, was erected as a temporary structure for the International Exhibition of 1862, and continued to be used thereafter by the Science Museum for exhibition purposes until the beginning of the War in 1939. For many years these galleries have been scheduled for destruction, and owing to their susceptibility to fire and bomb damage were a source of considerable anxiety during the War. The main portion of this old building is now being demolished to make room for a new centre block for the Science Museum, on the roof of which a planetarium is to be erected. It is anticipated that the ground floor and basement of this new building will be available in time to accommodate the science and technology portion of the Festival of Britain Exhibition in 1951. After this, work on the building will be continued and the building when completed will form the centre block of the Science Museum, with four floors of exhibition galleries. Arrangements for the occupation of this portion of the Science Museum are well under way, and it is anticipated that long before this additional accommodation becomes available, detailed arrangements for the display of specially appropriate and attractive exhibits will have been completed.

Scientific Instruments of George III

WHILE he was still Prince of Wales, the future King George III showed much interest in mechanics, optics, astronomy and scientific experiments of all kinds. Thus encouraged, the leading instrument makers of the second half of the eighteenth century constructed many models and apparatus for the instruction of the Prince. As might be expected, these models illustrate the craftsmanship of the period, and collectively they convey a remarkably clear impression of the general field of scientific study and experiment at that time. Fortunately, the instruments were preserved as a collection, and for many years they were kept at Kew Observatory. They were used again for instructing the many children of George III, and in 1841 they were presented to King's College, London. The collection was loaned to the Science Museum in 1926, but since 1928 it has been in store on account of the lack of space. It has now been placed on exhibition again and may be seen, until the end of September, at the Science Museum, South Kensington, London, S.W.7. Historically, the exhibition is of interest, as it covers an important era in scientific development—an era which witnessed the growth of modern physics and chemistry from the 'black magic' and haphazard alchemy of the Middle Ages, the development of such instruments as the thermometer, and great advances in the study of electricity. Science was becoming popular, but at the same time the foundations were being laid for progress on logical lines of experimental and theoretical philosophy. The course of instruction and the experiments performed tended to follow closely the lines laid down half a century earlier by the Dutch philosopher 'sGravesande, himself a disciple of Sir Isaac Newton, and one of the gems of the present exhibition is the 'Philosophical Table', which is similar to that designed by 'sGravesande. In the parlance of this more vulgar age, a 'philosophical table' is a 'laboratory bench'. Other items worthy of special note are the vacuum pumps made by George Adams and two fine microscopes constructed about 1750.

Commission on South African Museums

LAST year, in *Nature* of November 27, p. 861, it was reported that the Government of the Union of South Africa had set up a Commission to inquire into the financial position of certain State-aided institutions which, it was then understood, included certain museums, art galleries and zoological gardens. An announcement in the *Government Gazette* (*Pretoria*) for March 4 of this year extends the field of inquiry, and lists the institutions concerned, as follows: the South African Museum, Cape Town; the Transvaal Museum, Pretoria; the Natal Museum, Pietermaritzburg; the Orange Free State Museum and Monument Museum, Bloemfontein; the Voortrekker Museum, Pietermaritzburg; the South African War Museum, Johannesburg; the South African National Art Gallery, Cape Town; the Michaelis Collection, Cape Town; the National Zoological Gardens, Pretoria; and the National Botanical Gardens, Kirstenbosch.

The inquiry now covers not only the financial aspects of these institutions, but also their organisation and activity. The Commission is directed to make investigations and recommendations regarding the co-ordination of the research carried out by each institution; the possibility of co-operation between the named institutions, universities and other institutions towards a greater economy and efficiency in the preparation of material for exhibition and educational purposes; the advisability of forming a national board of trustees, or similar organisation, for the co-ordination of the work of the named institutions; the advisability of co-ordinating the research and education functions of the institutions and certain others not State-supported; the advisability of all or some of the named institutions becoming full State institutions; the incorporation of war museums in other museums; and the establishment of a science museum in Johannesburg. If the Commission finds that the last-mentioned is desirable, it is asked to make recommendations for its organisation and control. For the purpose of the inquiry outlined above, the Commission is given full authority to consult any person and Government book, record, etc. The wide scope of the inquiry and its importance demonstrate the formidability of the Commission's task, and it is indicative of a strong Government interest which will ultimately not only strengthen the efficiency of the Union's museum services, but will also point the way to even further developments.

Survey of India: Annual Report

THE Survey of India has issued a Civil Activities Report covering the period April 1, 1945–March 31, 1946, which replaces the detailed General and Geodetic Reports which have been in abeyance since 1939 but are to be introduced for the year 1946–47. Much of the work of the Survey during the year was directed towards the furtherance of a number of long-term projects, such as the Kosi, Mahanadi and Tista irrigation schemes. For these schemes somewhat rigid priority assessments had to be made owing to the shortage of men and instruments, and new and cheaper survey expedients were adopted to provide preliminary information. Even so, the routine topographical programme received scant attention. With the widespread resumption of civil surveys, the concentration of resources in Dehra Dun has been reversed, and the Eastern Circle controlling work in Assam, Bengal, Bihar and Orissa has been

re-established in Shillong. The Southern Circle has been re-created; but map publication is still largely concentrated in Dehra Dun, where also the projects officer is located. No new or revision topographical surveys or forest surveys were carried out during the year; but two settlement surveys were undertaken in the hilly districts of Kulu and Almora. Considerable progress has been made in replenishing stocks of quarter-inch maps corrected up to date; but for one-inch maps the present policy is to reprint the maps uncorrected pending the opportunity for surveying the necessary corrections. The series comprises 4,100 sheets, and in issuing corrected editions a start will be made with the most developed regions.

War experience as well as post-war activities have shown the need for a strong scientific body largely free from administrative responsibilities to enable the Survey of India to keep abreast of scientific thought and developments. The proposed Survey Research Institute, replacing the War Survey Research Institute, when constituted, will carry out the scientific functions of the Survey, and will also collaborate with the National Physical Laboratory, particularly in respect of standards of length and time. The Institute will be staffed and organised for work on measurements of length; standardization of measuring tapes, etc.; astronomical work as applied to latitude, longitude and time; tidal work; and magnetic observations. During the year the War Survey Research Institute carried out further investigations on the improvement of base-measurement apparatus and devised new methods of rapid fixation of position from stellar observations.

Linen Research Association: Report for 1948

The Linen Research Association, which is at Lambeg, Co. Antrim, has recently issued its annual report for the year ended September 30, 1948. The report records the opening of the new buildings in June; the installation of plant and equipment in the new technical shed for bleaching, dyeing and finishing is now almost complete. Delivery of machinery for the weaving section has also begun; but difficulties in recruiting well-qualified scientific staff have continued, although the accommodation for the increased staff planned in 1945 is now available. In view of the fall in home flax production, it is considered essential to continue research on flax production and to make another serious attempt to increase the yield of flax obtained from scutching. The total number of members is now 280, and the report includes lists of both members and staff and of the membership of committees. Research work carried out during the year has included a continued study of the effect of varying the retting process on the yield and quality of fibre produced from different types of straw, and also a study of the prevention of deterioration of the retted straw during drying. An investigation on a standard turbine scutching-machine has shown that low humidity has little effect on yield provided the straw contains about 14 per cent of moisture, but it greatly reduces the yield if the straw is dry; while at 85–90 per cent relative humidity in the turbine, dry straw can be scutched with a yield only slightly lower than that with properly conditioned straw. The investigation for the Ministry of Supply on the relation between fibre properties and yarn quality has been completed, and an investigation of 'dropped ends' has been started to determine the factors which limit the rate of production and the efficiency of spinning frames. Weaving tests have continued on a variety of yarns in automatic looms of the shuttle-change and pin-change types. Work on cloth bleaching has aimed at modifying existing processes to whiten fabrics with no degradation of the cellulose, and to secure the maximum durability; while work on dyeing has led to an improved method of securing penetration of vat dyes in linen fabrics.

Analysis of Management

In his paper, "The Nature of Management", based on an address to the London and District Society of Chartered Accountants, and now issued as "Occasional Papers No. 2" by the British Institute of Management, Sir Charles Renold insists that management is directed to action and that the action is at second-hand: management is concerned with guiding the actions of people other than the planners or guiders. Accordingly he regards management as fundamentally the process of getting things done through the agency of a community, and the functions of management as the handling of a community with the view of its fulfilling the purposes for which it exists. A large part of those functions is, in fact, concerned with the well-being of the team or community, and, in pursuing that well-being, the particular purpose of the community may be only of very indirect consideration. Sir Charles examines in some detail the requirements of community well-being so far as they are yet understood, emphasizing the importance not only of the structure or organisation of the community and procedures but also of their acceptance by the individuals forming the community. Contentment will not be secured unless there is confidence that rules and discipline are administered fairly, and the processes of using the team or community to achieve its purposes really turns on devising instructions appropriate to the situation. Planning he regards as a group of processes providing the raw material from which operative instructions are fashioned, and control as seeing how the plans are working out with the view either of modifying them or of improving the response of the community when necessary. Accountancy is one of the indispensable techniques of management; but he points out that every official in the course of his executive duties has to make decisions which are of the nature of policy, and the readiness to accept responsibility for making such decisions and the ability to make wise ones are as important elements in the qualifications of an official as is loyal compliance with orders. The statement that policy-making is the business of the board of directors and execution that of the management should not be accepted uncritically; and Sir Charles distinguishes policy-making as the establishment (not necessarily the origination) of an overall pattern of rules and principles from the development of these rules and principles into greater detail, and execution as their application to particular situations.

Problems in Astronomy

The Cawthron Lecture for 1947, with the title of "Problems in Astronomy, Solved and Unsolved", was delivered by F. G. Gibbs, curator of the Atkinson Observatory, Nelson, N.Z., and gives a very useful survey of the progress of astronomy during the last two decades. Some space is devoted to an examination of the theories of the source of stellar energy, and a short description is given of Bethe's carbon-cycle theory which is now generally accepted. A consideration of variable stars leads to the past

history of the sun, the heat of which has been shown by geological evidence to have varied considerably during the last 1,000 million years. Simpson's pluvial theory is dealt with—a theory which assumes that increased precipitation of moisture in the form of rain and snow was due to an increase in the heat of the sun—but no satisfactory explanation has yet been given of the cause of the variation in the sun's heat. Regarding novæ and super-novæ, no explanation is suggested beyond the statement that "atomic energy has no doubt something to do with it". Among some of the problems still awaiting solution are the origin of the solar system, the evolution of the stars, the structure and evolution of the universe, and cosmic rays. This lecture provides a very helpful summary of the progress of astronomy in comparatively recent times and also of the problems still awaiting solution, some of which appear more intractable now than they did twenty years ago.

Royal Scottish Museum : Natural History Department

With the re-opening of the Beasts of Prey Hall, the main halls and galleries belonging to the Natural History Department of the Royal Scottish Museum, Edinburgh, are now available to the public. These number twelve in all, allocated as follows : British fauna (2), mammals (3), extinct animals (1), foreign birds (1), amphibians and reptiles (1), fishes and molluscs (1), entomology (1), biology (1), and children's gallery (1). In addition, the study room, for use of students of the collections, is now open. During the War, many of the collections were removed, and the opportunity has now been taken to re-arrange much of the material. In addition, two specialist galleries for students are in use. An introductory hall entitled "The Story of the Earth", serving as an introduction to natural history and geology, is in course of preparation. A gallery of marine invertebrates is projected.

Universal Decimal Classification

The first abridgment of the full universal decimal classification in English has been published by the British Standards Institution as B.S. 1000 A. : 1948. It consists of 128 pages and costs 25*s*. It is intended for use in libraries or private collections where detailed subdivision of subjects is not required, or in special libraries using the full classification in a given subject but requiring an abridged classification for other fields. It is based on the official abridgment in the Dutch language, fifth edition, with the help, mainly in the sciences, of the abridgment published by H.M. Stationery Office, under the title "Classification for Works in Pure and Applied Science in the Science Museum Library", third edition. The abridgment should form a useful introduction and guide to the complete fourth edition in English, which is being published by the British Standards Institution, section by section.

Correction of Magnesium Deficiency in Tomatoes

Magnesium chlorosis is widespread among tomatoes grown under glass in Great Britain. It probably causes a considerable loss of yield, and economic methods for its correction are therefore urgently required. D. J. D. Nicholas shows (*J. Hort. Sci.*, 24, No. 1, 1–18 ; June 1948) that this can best be accomplished by sprays of two per cent of magnesium sulphate applied to the foliage five times at intervals of two or three weeks. This results in the application of less than 5 cwt. per acre, compared with 10–20 cwt. of calcined kieserite, found necessary for soil applications. Soil factors probably immobilize a large proportion of the soil dressings of magnesium sulphate. Interactions of magnesium with potassium and nitrogen are also discussed in the paper.

Chelsea Polytechnic

The fifty-third annual report of Chelsea Polytechnic is interesting because of the attractive way in which its items have been presented. Besides the usual information about the number and range of classes and examination successes, the report contains a detailed analysis of the occupations of evening students, the geographical distribution of students, the kind of research undertaken by advanced students and particulars of services rendered by members of the staff in a voluntary capacity to various kinds of learned and other societies. The examination statistics show that, during the last two years, one D.Sc., five Ph.D.s and seventeen M.Sc.s were obtained, figures of considerable significance for those who wish to see some evidence that the recommendations of the Percy Committee on Higher Technological Education have not been forgotten. This report, so clearly and precisely presented, is a fine example of what such a document can be in building up the corporate spirit of a large institution.

New Zealand Earthquakes during October 1948

Nine strong distant earthquakes were registered during October 1948 by the New Zealand seismographs situated at Auckland, Arapuni, Christchurch, Kaimati, New Plymouth, Tuai and Wellington, according to the report from the Dominion Observatory, Wellington. In addition, eighteen earthquakes and tremors were felt by people in New Zealand during the month. The greatest of these had instrumental strength $4\frac{1}{2}$ and was felt at Dunedin and Monowai on October 9. The next most intense had instrumental strength $4\frac{1}{4}$, and these were felt on October 16 at Otaki and Wanganui, and on October 29 at Hanmer Springs.

Editorial Board of *Chymia*

The University of Pennsylvania Press has announced the appointment of Henry M. Leicester, professor of biochemistry, College of Physicians and Surgeons in San Francisco, as editor-in-chief of *Chymia : Annual Studies in the History of Chemistry*. Dr. Leicester, who succeeds the late Tenney L. Davis as editor, is chairman of the History of Chemistry Division, American Chemical Society, and associate editor of the *Journal of Chemical Education*. Prof. John Read, professor of chemistry and director of the Chemistry Research Laboratory, University of St. Andrews, is the new associate editor of *Chymia*. Other members of the editorial board are : Claude K. Deischer, Rudolf Hirsch, Herbert S. Klickstein and Eva V. Armstrong.

University of London : Appointments

The following announcements of appointments have recently been issued : Prof. H. C. Darby has accepted an invitation to the University chair of geography tenable at University College, and Mr. W. O. Lester Smith to the University chair of sociology of education tenable at the Institute of Education, both as from October 1, 1949. Dr. P. E. Vernon has been appointed to the University chair of educational psychology tenable at the Institute of Education, as

from October 1, 1949. Appointments to readerships: Dr. E. T. Eady to the University readership in physical climatology tenable at the Imperial College of Science and Technology, as from October 1, 1949; Dr. A. J. Marshall to the University readership in zoology and comparative anatomy tenable at St. Bartholomew's Hospital Medical College, as from October 1, 1949; Mr. N. H. Martin to the University readership in chemical pathology tenable at St. George's Hospital Medical School, as from April 1, 1949; Dr. J. R. Raeburn to the University readership in agricultural economics tenable at the London School of Economics, as from October 1, 1949; Dr. J. W. Smith to the University readership in chemistry tenable at Bedford College, as from October 1, 1949.

University of Bristol: Appointments

Dr. H. S. Heller, reader and head of the Department of Pharmacology and Practical Pharmacy in the University of Bristol, has been appointed the first occupant of the new chair of pharmacology in the University. Dr. H. A. Heilbronn, reader in pure mathematics in the University, has been appointed to succeed Prof. H. R. Hassé as Henry Overton Wills professor of mathematics. Both these appointments take effect in the session 1949–50.

Announcements

The Stamp Memorial Lecture will be given at the Senate House, University of London, by Prof. A. C. Pigou, emeritus professor of political economy, University of Cambridge, on May 13 at 5.30 p.m.; he will speak on "Wage Statistics and Wage Policy". Admission is free, without ticket.

The Silvanus Thompson Memorial Lecture for 1949 of the British Institute of Radiology will be delivered by Dr. F. G. Spear, of the Strangeways Research Laboratory, Cambridge, at the Institute on April 28; he will speak on "The National Radium Commission in Retrospect".

The thirty-seventh Wilbur Wright Memorial Lecture of the Royal Aeronautical Society will be given by Dr. Hugh Dryden, director of aeronautical research to the National Advisory Committee for Aeronautics, at the Royal Institution, London, on April 28 at 6 p.m.; Dr. Dryden will speak on "The Aeronautical Research Scene—Goals, Methods and Accomplishments".

In connexion with the series of lectures on the "Development of Taxonomy" given at the rooms of the Linnean Society during the past winter, there will be a demonstration at the Herbarium, Royal Botanic Gardens, Kew, on May 7 at 2.30–5 p.m. The demonstration, which has been arranged by the Linnean Society and Systematics Association, will illustrate the history and methods of botanical taxonomy from 1753 to the present day, and is primarily intended for advanced university students and teachers.

Dr. T. W. Parker has recently been appointed deputy director of building research in the Department of Scientific and Industrial Research. Dr. Parker, who was educated at the University of Durham, joined the staff of the Building Research Station in 1930. His research work has been mainly concerned with building materials and their use in structures. For some years he was also responsible for the Station's programme of work at the Fire Testing Station, Elstree, before this was taken over by the Fire Research Organisation of the Department.

The Challenger Society is prepared to consider applications for small grants in aid of research in marine biology or oceanography at a recognized laboratory during the year June 1949–June 1950. Applications, accompanied by details of the proposed research, should reach the honorary secretary, Mr. N. B. Marshall, British Museum (Natural History), London, S.W.7, before the end of May.

An award is to be made of the studentship in experimental and mathematical aeronautics research established in memory of Edward Teshmaker Busk, who in 1914 lost his life while flying an experimental aeroplane. The studentship, which is worth £165 and tenable for one year at the University of Cambridge, is open to any British man or woman less than twenty-five years of age. Full details may be obtained from the Professor of Aeronautical Engineering, Engineering Laboratory, Cambridge.

The Medical Research Council is offering the following travelling fellowships for the academic year 1949–50: Rockefeller medical fellowships for postgraduates resident in Great Britain to work in the United States or elsewhere; Dorothy Temple Cross research fellowships in tuberculosis for British subjects to work elsewhere than in Great Britain. Both fellowships are worth £650 per year and there are travelling allowances and a £250 marriage allowance. Application forms, to be completed by June 1, may be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, Westminster, London, S.W.1.

An exhibition of calculating machines and equipment will be held in the Firth Hall, University of Sheffield, during April 29 (2.30–8.0 p.m.) and April 30 (10.0 a.m.–6.0 p.m.). The exhibition will be opened by Prof. D. R. Hartree, Plummer professor of mathematical physics, University of Cambridge, who will speak on "Some Recent Developments in Calculating Machines". Lectures will also be given by Mr. G. B. Hey (Trustee Department, District Bank, Ltd.) on "Applications of Punched Card Machines in Accounting and Scientific Computing", and Dr. E. T. Goodwin (Mathematics Division, National Physical Laboratory) on "Calculating Machines: their Nature and Applications". Admission is free.

The Coal Tar Research Association, now incorporated under the Companies Act of 1948, has leased premises at Gomersal, near Leeds, for its research station. It is expected that the headquarters of the Association will move from the present address, 9 Harley Street, London, W.1, in June and that the laboratories will be completed later in the year.

The National Physical Laboratory at Teddington is holding an 'open day' on May 26 from 2.30–6.0 p.m., to which representatives of industrial organisations are being invited. This is an opportunity for members of industry to see the wide range of scientific research and investigational work undertaken at the Laboratory, and a number of tickets is being reserved for postal applications. Accredited representatives of industrial organisations who would like to visit the Laboratory and who are not already in contact with its work are invited to apply to the Director, National Physical Laboratory, Teddington, Middlesex, not later than May 14.

Erratum.—In the communication entitled "Shape Factor in Particle-Size Measurement" in *Nature* of April 2, p. 527, line 5 from end, for "K is then the standard deviation" read "K_s is then the standard deviation . . ."

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Optical Properties of Barium Titanate

A PAPER by Kay in the *Acta Crystallographica* for November 1948 has just appeared which traverses ground so close to that which we have been exploring during the past two years that it seems desirable to announce at once a few points which seem to be both new and interesting in our work.

In 1946 one of us (R. W.) observed that 'Barkhausen clicks' occurred when a commercial ceramic titanate condenser (Dubilier) was electrically connected in a suitable circuit. We then, in pursuit of the problem, prepared single barium titanate crystals and examined them in polarized sodium light under various conditions of temperature (−5° to 140° C.) and in electric fields up to about 30,000 volts/cm. The well-known twinning (101 and 011 types) was immediately apparent in our small crystals, and in Fig. 1 is shown a scale model of just one example built up on an actual photograph (× 500). This photograph with its legend is self-explanatory.

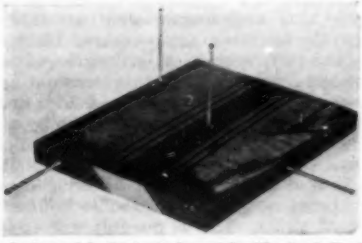

Fig. 1. Scale model of a typical crystal with pins indicating the direction of the optic axis in the twin components

The application, at room temperature, of an electric field of sufficient strength causes the *c*-axis to turn into the field direction throughout the crystal, a change usually achieved by the growth of small wedge-shaped needles lancing out at 45° from a crystal edge, which, when long enough to extend right across, begin to expand at right angles to their length, finally devouring the whole crystal. This movement may be quite slow, lasting minutes, and is often accompanied by light and dark lines which appear transiently, parallel to the *c*-axis, when viewed between crossed Nicols near the extinction position. At a twin boundary, these transient lines turn abruptly through 90°, as shown in Fig. 2, which,

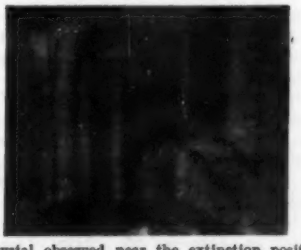

Fig. 2. Crystal observed near the extinction position in an alternating field of 20 kV./cm. (× 750)

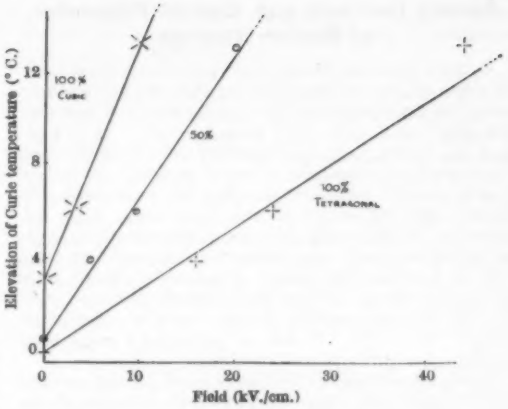

Fig. 3

for reasons we cannot here elaborate, was taken in an alternating field at room temperature. It is thought that this phenomenon may be connected with a change of spontaneous polarization through 180°, these two directions being optically indistinguishable in the steady state.

We have specially examined the behaviour of these small crystals in the neighbourhood of the Curie temperature, the highest value of which was found to be about 121° C. At this temperature the structure changes from tetragonal to cubic; but this transition is inhibited by the application of an electric field, so that with fields approaching breakdown the transition does not occur until as high a temperature as 130° C. is reached. This effect, which has its counterpart in ferromagnetics, is approximately summarized in Fig. 3.

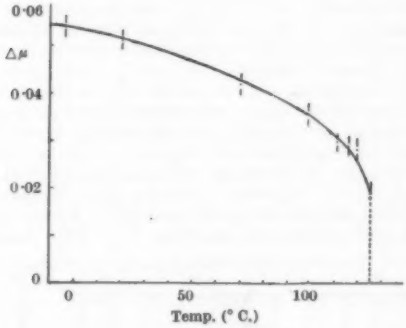

Fig. 4

We have also measured, by examination of the interference fringes shown in Fig. 1, the birefringence ($\Delta\mu$) over a range of crystal temperature. The results are shown in Fig. 4, and are in general agreement with the c/a curves published by Megaw[1]. We find that approximately $\Delta\mu = 5{\cdot}5\ (c/a - 1)$.

L. E. CROSS
A. T. DENNISON
M. M. NICOLSON
R. WHIDDINGTON

Department of Physics,
University of Leeds.
Dec. 16.

[1] Megaw, H. D., *Proc. Roy. Soc.*, A, **189**, 261 (1947).

Atomic Positions and Optical Properties of Barium Titanate

In view of recent discussion[1,2] of possible departures of some of the atoms of tetragonal barium titanate from the centrosymmetrical configuration of the unit cell (Ba^{+2} at 0, 0, 0; Ti^{+4} at $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$; O^{-2} at $\frac{1}{2}$, $\frac{1}{2}$, 0; $\frac{1}{2}$, 0, $\frac{1}{2}$; and 0, $\frac{1}{2}$, $\frac{1}{2}$), the following may be of interest. Oscillation photographs of an untwinned crystal of nearly square cross-section (12 : 13) have been obtained, and reflexions of the type h,0,0, 0,0,l, examined. No intensity differences between these pairs of reflexions have been observed by eye, and from this it is concluded (using F values obtained from the International Tables) that there is no simple shift of the Ti^{4+} ion parallel to the c-axis by more than 0·05 A. or of the O^{2-} ion at $\frac{1}{2}$, $\frac{1}{2}$, 0 by more than 0·13 A. from the above positions.

Since movements of this magnitude cannot account for the observed value[3] of the dipole moment of the unit cell, this (if its value is confirmed) must result in the main from an effective displacement of outer electrons only, arising from some system of partly polar bonds such as has previously been suggested[1]. We may add here that oscillation photographs of crystals of the hexagonal modification of barium titanate have also been obtained which show that this has a slightly more open structure than the tetragonal form, and that the lengths of the Ba—O and Ti—O bonds are again different in different directions.

It is hoped shortly to establish the exact parameters of the tetragonal crystal to a higher degree of accuracy with the aid of Weissenberg photographs.

The uniaxial character and orientation of twins in barium titanate have been confirmed by optical observation between crossed Nicols, using a quartz wedge.

Observations on thin plate-like crystals having their tetragonal c or optic axis in the plane of the plate have shown that the usual method of twinning often results in a pair of boundaries having a separation of approximately 10^{-4} cm. Such pairs or 'double boundaries' may terminate within the crystal by oblique junction, or may extend right across it with constant separation. The enclosed material has its optic axis perpendicular to that of the adjacent twins and also in the plane of the plate, so that an isolated 'double boundary' consists of a thin lamella of material having its polar direction perpendicular to the rest of the crystal (Fig. 1). The double-boundary separation appears to be independent of the crystal thickness and shape, and to have a minimum value of approximately 2×10^{-4} cm. This twin formation is one which will relieve internal shear stresses in a crystal and will result in minimum change in external shape.

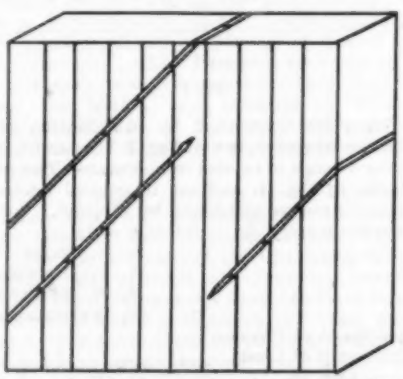

Fig. 1. Twinning in $BaTiO_3$ crystals; shading shows direction of c axis

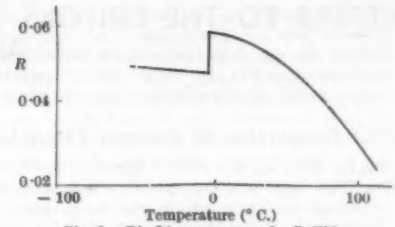

Fig. 2. Birefringence curve for $BaTiO_3$

The birefringence (R) has been measured for a large number of crystals by a rapid method, using white light. The absolute value varied from 0·50 to 0·59 at 30° C. The variation of (R) in the temperature range — 50° to 120° C. was also measured for a few crystals by a compensation method using filtered radiation. Fig. 2 shows the relation between the birefringence (R) and temperature (θ). The curve between — 5° C. and ~ 120° C. fits the equation $(K - R) = \alpha(T - \theta)^2$, where $K = 0{\cdot}62$ is the maximum value of R at ~ — 5° C. and R changes discontinuously; α is a proportionality constant which depends on the transition temperature. The variation of $c - a$, the difference in axial lengths of the unit cell, is of the same form, so that there is a simple linear relation between $(c - a)$ and R. From the value of R we may therefore tentatively calculate the axial ratio in any part of the crystal under other conditions.

There is a difference in the birefringent colours of the material enclosed in a double boundary and the adjacent twins. This is possibly due to the fact that c/a is less in these areas, this reduction being the result of the mechanical and electrical stresses around a double boundary, which may also determine its separation.

The orientation of c in the double boundaries is confirmed by the application of an electric field. Then their length and separation increases or decreases as the field is parallel or perpendicular to their c direction. Another transition occurs at — 5° C. The optical behaviour suggests that the tetragonal unit-cell shears in the (001) plane, the new axes being approximately parallel to the [110], [110] and [001] directions of the original cell, the symmetry being orthorhomic. Assuming the relation between $(c - a)$ and R applies approximately in this region, $(c - a)/a$ is reduced by approximately 15 per cent at the transition at — 5° C. and increases slightly at still lower temperatures. Further investigations by X-ray methods are to be undertaken.

The application of electric fields of approximately 2×10^4 volts/cm. to twinned crystals has resulted in complete orientation of the tetragonal axis along the field direction (that is, electric saturation). The field across the crystal itself is very much less, because of the high dielectric constant of barium titanate, together with the air-gap between the crystal and electrodes. This gap is an essential condition, since the crystal expands along the field axis in the process, c being greater than a.

Note added on January 26, 1949. The transition at ~ — 10° C. has been studied by X-ray methods,

a shear of 14′ in the $a - c$ plane being observed at $-16°$ C. ($\beta = 89° 46'$). Associated with this change there is an expansion of the a parameter and a slight contraction of c, such that these two parameters become equal, and the polar direction turns through 45° into the [011] or [101] direction. A further transition occurs near $-70°$ C., below which temperature the symmetry appears to be rhombohedral with the polar axis in the former [111] direction.

H. F. Kay
H. J. Wellard
P. Vousden

H. H. Wills Physical Laboratory,
University of Bristol. Oct. 20.

[1] Megaw, *Proc. Roy. Soc.*, A, **189**, 261 (1947).
[2] Discussion of Electronics Group of Institute of Physics, *Nature*, **162**, 245 (1948).
[3] Hulm, *Nature*, **160**, 127 (1947).

A New Application of White-Light Superposition Fringes

White-light superposition fringes have found a number of applications in the past. They are of two kinds—fringes of equal inclination and of equal thickness. Extensive use of the former has been made, first in Brewster fringes, later in the Jamin interferometer; then in 1898 Fabry and Buisson first used multiple-beams, ultimately adopting the fringes for their classical evaluation of the metre. A more recent application has been made by Sears and Barrell in determining the refractive index of air.

Comparable use of white-light superposition fringes of equal *thickness* has not, however, been made; apart from a few experiments described by Fabry in his book "Les Applications des Interférences Lumineuses" (1924), there is little to record. It is the purpose of this note to describe a simple application which reveals qualitative information with high precision.

It has already been demonstrated by interferometry that many varieties of muscovite mica cleave surprisingly true over large areas. A randomly selected sheet of muscovite was silvered on both sides. It was then cut into two with scissors and the two pieces held superposed on each other. The combination was placed in the parallel beam of a standard Fizeau fringe set-up, but with white light. Thus an image of a 'Pointolite' is thrown on to an aperture which is at the principal focus of a lens, and the emergent parallel beam of white light directed at normal incidence on to the mica combination. A lens follows the mica, and the eye is placed at the lens focus. The appearance is striking. Following recognized principles, it is clear that localized white-light superposition fringes of equal thickness will form. If the two pieces of mica consisted of pieces of strictly constant thickness, then the field of view would consist merely of a uniform tint of illumination. But, in fact, there are cleavage steps on mica surfaces and, as is already known, these usually occur in simple multiples of the crystal lattice spacing (20 A.) and may, in fact, be only a single lattice high. It is clear that the superposition principle leads effectively to the production of thin-film interference over path-differences representing the heights of the cleavage steps. The result is that the field of view shows brilliantly coloured areas, each of uniform tint, each being delineated by the boundary of cleavage lines. Thus, in a highly sensitive (but only qualitative) manner, the structure of the mica sheet is revealed. For not only do height changes lead to colour variations, but also inclusions and variations of refractive index have a like effect.

It remains to ask whether this rather restricted new technique has any advantages over the monochromatic multiple-beam method already in use for thin films. The answer is, yes. In two respects the new method is a decided improvement on the old. First, when using monochromatic light, the very sharpness of the fringe distribution is such that cleavage steps may easily be missed if the transmission region corresponds to a thickness well off the intensity maximum; secondly, it can be readily demonstrated by simple calculation that the fringe-width in the combination system is $1/\sqrt{2}$ that in the single system. There is, therefore, a 40 per cent increase in sensitivity.

It is to be emphasized that the interference colours are determined primarily by the individual step-heights and not by the thickness of the mica sheet. With very strict collimation, it should certainly be possible to apply the technique to thick slabs. This being so, equal slabs of optical material can be exactly matched and accurately surfaced, for example, with the dividing plate and compensating plate in a Michelson interferometer, or the plates for a reflexion echelon, etc. Other applications, with both thin and thick interference gaps, come readily to mind.

S. Tolansky

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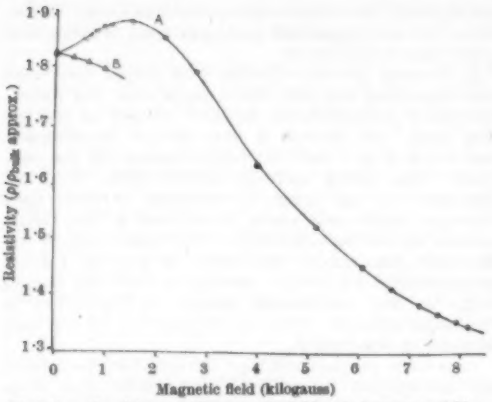
Englefield Green, Surrey.
Oct. 29.

Influence of a Magnetic Field on the Size-Variation of Electrical Conductivity

Miss I. Stone[1], in 1898, appears to have been one of the first to make a study of the anomalous increase in specific resistivity of very thin metal films as compared with specimens in bulk, although the phenomenon was already known. Films of silver as thin as $\sim 1 \times 10^{-6}$ cm. deposited by the 'Rochelle salt process' were used by her. Longden[2] extended this work to evaporated films of platinum, and since that time a considerable amount of work has been carried out on such thin films (for example, bibliography in ref. 3). J. J. Thomson[4] first proposed that the physical limitation of conductor size would produce a shortening of the electron mean free path, with a consequent reduction of effective conductivity, and derived a theoretical expression based on an assumption of a constant mean free path in the bulk metal.

More recently, the accessibility of very low temperatures has enabled the effect to be observed in specimens of considerably larger size (~ 10–$100\,\mu$), with the resulting elimination of a number of subsidiary effects which arise in very thin films. In particular, Andrew[5] has studied wires of pure mercury and wires and foils of pure tin in the region 1–4° K. One difficulty, emphasized by Andrew, in the interpretation of the data is that of relating the measured conductivity to that of an equivalent bulk sample, since strain and impurity—both productive of high residual resistance at low temperatures—may be expected to play a significant part in finer specimens.

Modern theories of metallic conduction as applied to the phenomenon[6] require an assumption of the degree of 'freeness' of the conduction electrons. It



Variation of resistance with magnetic field: *A*, transverse field; *B*, longitudinal field. (Temp. 4·2° K.)

was therefore considered that an investigation on fine specimens of pure sodium would be worth while, since earlier work on the alkali metals[7] had suggested strongly that the conduction electrons in sodium are almost ideally free. It was also intended in this work to examine the effect in relation to temperature from 20° K. to ~4° K., to deduce any variation of the surface reflexion coefficient. Results in this field will be published later; but an interesting effect has been observed when a magnetic field is applied.

The accompanying graph shows the observed variation of electrical resistance in a specimen 30 μ diameter under the application of transverse and longitudinal fields. It is immediately obvious that the effect is essentially of a different character from the customary increase of resistance in a magnetic field (magneto-resistance effect). The remarkable reduction of resistance may be understood if one observes that in a field of ~4,000 gauss the conduction electrons in sodium will describe classical orbits of diameter 30 μ. Thus, for example, an electron, having been scattered from one surface of the metal, may have its path so curved by the magnetic field as to avoid subsequent collision with the opposite wall of the specimen and thus have an increased effective path-length. Ultimately, for a sufficiently strong longitudinal field, one would expect that scattering by the walls would become insignificant in comparison with that in the body of the metal. In this case the resistivity should approach a lower limit, namely, that of the metal in bulk. In a transverse field, a similar decrease should occur, although the limiting resistivity will then be greater than that of the bulk material since those electrons travelling more or less parallel to the field will still collide with the walls. With a transverse field, elementary considerations show also that some electrons, dependent on their direction of motion, will suffer an initial diminution of free path which may predominate, although ultimately all free paths should increase. This effect is obvious in the graph, the resistance reaching a maximum around 1,500 gauss for this specimen. On the other hand, one would only expect a progressive increase of free path with a longitudinal field, the electrons pursuing spiral paths around the lines of force. The experimental data confirm this assumption. Measurements on specimens of different sizes under varying fields should provide a knowledge of mean free path and surface scattering coefficient individually: publication of full experimental data and theoretical discussion will follow later.

In conclusion, one may note that this phenomenon is to be distinguished from the diminution of the magneto-resistance effect in very thin films as observed by Patterson[8] and explained by Thomson[4]. In that case, the increased electron-scatter in bulk metal arising from the action of a magnetic field loses its effect as the electron free path becomes curtailed by the physical limits of the specimen.

D. K. C. MacDonald

Clarendon Laboratory,
Oxford. March 5.

[1] Stone, I., *Phys. Rev.*, **6**, 1 (1898).
[2] Longden, A. C., *Phys. Rev.*, **11**, 40, 84 (1900).
[3] Bartlett, R. S., *Phil. Mag.*, **5**, 848 (1928).
[4] Thomson, J. J., *Proc. Camb. Phil. Soc.*, **11**, 120 (1901).
[5] Andrew, E. R., *Proc. Phys. Soc.*, **62**, 77 (1949).
[6] Fuchs, K., *Proc. Camb. Phil. Soc.*, **34**, 100 (1938).
[7] MacDonald, D. K. C., and Mendelssohn, K., *Nature*, **161**, 972 (1948).
[8] Patterson, J., *Proc. Camb. Phil. Soc.*, **11**, 118 (1901).

Fermi Resonance in Benzene

The existence of a strong doublet rather than a singlet line in the Raman spectrum of carbon monoxide was explained by Fermi[1] on the theory that when in multi-atomic molecules the frequencies of two independent vibrations are commensurable or nearly so, the vibrations perturb each other, resulting in a mutual repulsion of the two levels and a mixing of eigenfunctions, provided the two vibrations belong to the same symmetry species. Such Fermi resonance is found to occur frequently in many polyatomic molecules, and enables one to explain some characteristic features of Raman and infra-red spectra. For example, it is well known that the Raman spectrum of benzene exhibits two strong lines due to frequencies 1606 cm.$^{-1}$ and 1584 cm.$^{-1}$, whereas only one at 1596 cm.$^{-1}$ is to be expected corresponding to the e_g^+ vibration. The occurrence of this doublet was shown by Wilson[2] to be due to Fermi resonance between 1596 cm.$^{-1}$, which is a pure e_g^+ frequency, and a binary combination 606 cm.$^{-1}$ + 992 cm.$^{-1}$ = 1598 cm.$^{-1}$, the total eigenfunction of which has again the e_g^+ symmetry.

In the course of an analysis of the near ultra-violet emission bands of benzene[3], we have discovered an extended series of such Fermi doublets. The main characteristics of the emission spectrum are represented by progressions of totally symmetric vibrations superposed over one of the e_g^+ vibrations in either state, which circumstance is essential to permit the otherwise forbidden transition. The extended series of Fermi doublets arises in the superposition of one to four quanta of 992 frequency on each of the fundamental doublets, each of which again is loaded with one to four quanta of 160, the difference frequency. The observed data are in agreement with theoretical calculations based on first-order perturbation brought about by the cubic anharmonicity factor in the potential energy function of the molecule.

A detailed account has been submitted for publication elsewhere.

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M. E. Padhye

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Oct. 16.

[1] Fermi, *Z. Phys.*, **71**, 250 (1931).
[2] Wilson, *Phys. Rev.*, **46**, 146 (1934).
[3] Asundi and Padhye, *Nature*, **156**, 368 (1945); "On the Emission Spectrum of Benzene in the Near Ultra-violet" (unpublished).

Low-Level Atmospheric Ducts

In a recent communication in *Nature*[1], McPetrie and Starnecki have directed attention to the presence of atmospheric ducts at or close to the sea surface. The presence of low atmospheric ducts when the air at 100 ft. above sea-level was colder than the sea was found difficult to explain, and it was noted that such ducts were frequently associated with high wind speeds.

In a recent paper[2] of limited circulation dealing with observations in Cardigan Bay, I have shown that the mean specific humidity, s, of the air in the layer between 200 and 2,000 ft. above the sea, after an uninterrupted sea track, is related to the saturation specific humidities at the sea surface temperatures during the previous 48 hours history of the air by an expression of the form

$$s = 0{\cdot}34\ (s_1 + s_2),$$

where s_1 is the saturation specific humidity at the sea surface temperature at the place of observation, and s_2 that for the sea surface temperature at the place where the air was 48 hours before. Thus the lower the value of s_2 (s_1 varies only slowly with time and is sensibly constant over a period of days at a particular place in Cardigan Bay) the lower the value of s, and hence the greater the value of the humidity lapse in the lowest layers of the air. In the same paper[2], it is suggested that much the greater part of this humidity lapse frequently occurs in the lowest few feet of the air. If the air under examination comes from an area where the sea surface temperatures are much lower than in Cardigan Bay, then the stronger the wind the colder the sea surface temperature at the place the air was 48 hours before, and the greater the value of the humidity lapse in the Cardigan Bay area. The occurrence of low-level radio ducts in conditions of high winds when the air temperature is substantially less than the sea surface temperature can therefore be explained on this basis alone. The occurrence of ducts when the air temperature at 100 ft. was substantially above the sea temperature can almost certainly be explained by the presence of air which had recently come from the warmer and drier land, with the consequent presence of both temperature inversion and humidity lapse in the lowest layers, leading to even stronger ducts than those considered above. It is extremely unlikely that temperature inversions of such magnitude accompanied by a marked humidity lapse could occur over the sea, except in the neighbourhood of a warmer land mass.

I am indebted to the Director of the Meteorological Office for permission to submit this note.

R. F. Jones

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Nov. 30.

[1] *Nature*, **162**, 818 (1948).
[2] Jones, R. F., "Temperature and Humidity Structure of Lowest Layers of the Air over the Sea", Air Ministry, J.M.R.P. No. 92 (1947).

We are grateful to Mr. Jones for outlining his suggestion as to a possible method for the formation of the low-level atmospheric ducts in Cardigan Bay which we postulate from our radio field-strength measurements. According to current radio-meteorological theory, ducts should not occur during turbulent conditions. It surprised us, therefore, to find from the radio measurements that in the winter high field-strengths, which suggest to us the presence of low-level ducts, could occur even during windy weather. Mr. Jones's hypothesis gives a very satisfactory quantitative explanation of a method by which ducts might be formed during such periods of high wind velocity. High field-strengths during winter, however, appeared to depend more on the fact that the temperature of the air was appreciably lower than that of the sea, rather than on the presence or absence of wind. The main difference between windy and still conditions was not in the amplitude of the received signal but in its stability, remarkably little fading ever being found during windy periods.

Sverdrup, in his book "Oceanography for Meteorologists", arrives at the conclusion that the greatest evaporation occurs when cold air flows over warm water; as in middle and higher latitudes in winter the sea surface is mostly warmer than the air, evaporation should be a maximum in winter and not summer, as generally supposed. Sverdrup's results, while only qualitative, seem to us to account satisfactorily for the possibility of ducts occurring during still air conditions in winter. Sverdrup also concludes that the evaporation should be increased at higher wind velocities because of the presence of spray—a hypothesis which we tentatively suggested in our note to explain the presence of ducts during windy conditions.

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Preparation of Radioautographs to Show the Distribution of Phosphorus-32 in Plant Tissues

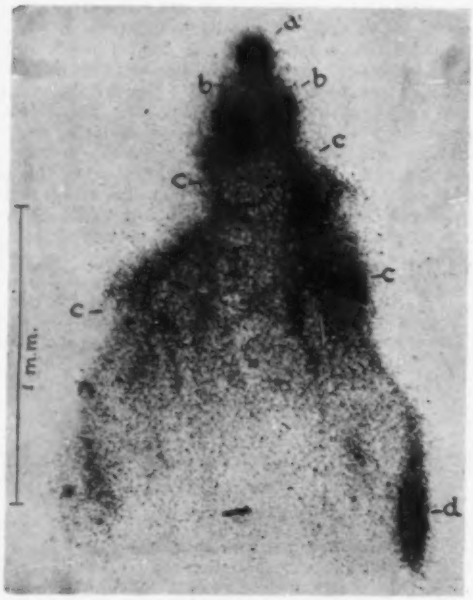
Pelc[1] has developed a radioautographic technique to show in microscopic detail the accumulation of iodine-131 in the thyroid gland. A thin 'stripping' photographic emulsion is floated on to the tissue sections mounted on a glass slide. The precision with which the tracer can be located within the tissue depends not only on the thinness of the section and the emulsion but also on the closeness of contact between them. In applying this method to the study of the distribution of phosphorus in plant tissues the following complications arise: (1) a considerable diffusion of phosphorus occurs in the fixatives normally used; (2) the time required to prepare sections by standard plant histological methods is so long that much of the tracer decays before the radioautograph can be exposed.

We have found that these difficulties can be largely overcome by employing a 'freezing substitution' technique which one of us (F. K. S.) is developing for other purposes, and following this by a rapid imbedding method. The time required for preparing sections of material such as cereal root tips has thereby been reduced to twenty-four hours.

The tissue is frozen in *iso*pentane chilled to about − 170° C. and then transferred to absolute alcohol saturated with basic lead acetate, which is maintained at − 70° C. in a jacket of 'dry ice' alcohol. The ice in the tissue *dissolves* slowly in the cold alcohol

and the phosphate is precipitated *in situ* as the lead salt. The material thus fixed and largely dehydrated is then imbedded in paraffin wax using tertiary butyl alcohol[2] as a solvent and sectioned in the normal way. Radioautographs are then made by the method of Pelc[1].

Since it is necessary to keep the concentration of tracer below a level at which radiation damage is likely to occur[3], thin fine-grain emulsions such as that described by Berriman[4] and Stevens[5] are usually too slow. A faster Kodak experimental radioautographic stripping emulsion has therefore been used. On account of its thickness, this emulsion gives poorer resolution, but points of accumulation of tracer approximately 15 μ apart can be distinguished one from another.



Radioautograph showing distribution of radioactive phosphorus in the stem apex of a young barley plant

The results so far obtainable by this method are illustrated by the accompanying radioautograph of the stem apex of a young barley plant in longitudinal section. The section was 15 μ thick, and the exposure time eighteen days. Concentration of phosphorus occurs especially in the apical meristem (*a*), the leaf primordia (*b*), the bases of the younger leaf sheaths (*c*) and the initial of an adventitious root (*d*). Parts of the vascular tissue also show some accumulation. For the sake of clarity in reproduction, the radioautograph was removed from the section before it was photographed. The most convenient method for locating the site of accumulation of the tracer is, however, to examine the radioautograph and section in contact. Since it is difficult to stain tissues in contact with emulsions, the phase-contrast microscope is useful for this purpose.

Fuller details of the histological and radioautographic techniques will be published elsewhere.

We are indebted to the Agricultural Research Council for providing a grant in aid of the tracer work the Department of Agriculture; we wish also to thank Dr. S. R. Pelc of the Medical Research Council Radiotherapeutic Unit for much valuable advice, and Dr. R. H. Herz and the Kodak Research Laboratories for the gift of the photographic emulsions.

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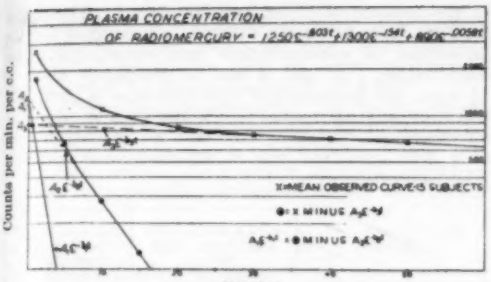
Regression of a Radioactive Mercurial Diuretic from the Plasma of Man

During the study of the mechanism of chronic congestive heart failure and other œdematous states, it became more evident that there is need for a better understanding of the pharmacodynamics of mercurial diuretics. Investigations have been carried out with the use of radioactive mercury incorporated in a mercurial diuretic, 'Mercuhydrin' (sodium salt of methoxyoximercuripropylsuccinylurea with theophylline, prepared in this laboratory by Messrs. H. Krahnke, E. Sprengler and D. Kaestner through the courtesy of Dr. H. L. Daiell of Lakeside Laboratories, Milwaukee, Wisconsin, with the use of mercury-203–205 from the A.E.C. Oak Ridge Operations), in order to observe for a period of 100–180 min. the concentration-time course of the isotope in the plasma of man after intravenous injection.

Fifteen subjects were studied. 2 c.c. of labelled mercurial diuretic was injected into the antecubital vein of one arm of the subjects over a period of about 20 sec., and blood samples were drawn rapidly from the antecubital vein of the contralateral side. The interval between collection of blood samples was 4–8 sec. for the first two or three minutes, thereafter increasing as the experiment progressed. After the blood was centrifuged, 0·3 c.c. of serum was placed upon a filter paper disk, allowed to dry and cemented to a metal disk for counting. Measurements of radioactivity were recorded as counts per minute per cubic centimetre of fluid, and were corrected to values corresponding to an injected activity of 10,000,000 counts per minute of radioactive mercury.

The regression-curves observed in all subjects were similar. The accompanying graph, the composite regression curve of all fifteen subjects, is analysed graphically into three exponential rates of regression.

The regression-rates contributing to the concentration-time course of radioactive mercury in the plasma of man are not simple phenomena; rather they are probably the expression of many simultaneously occurring physico-chemical processes. The most rapid regression-rate is brought about largely by mechanical mixing of the tracer in the plasma along with some extremely rapidly occurring biological events. The second regression-rate probably expresses the filling of the potential mercury spaces and the activation of 'potential turnover patterns' for mercury, including diffusion and chemical reactions, which did not actually exist until a relatively


PLASMA CONCENTRATION
OF RADIOMERCURY = 1250e^-.803t + 300e^-.141t + 850e^-.0091t
Counts per min. per c.c.
X-MEAN OBSERVED CURVES SUBJECTS
●-X MINUS A e^-.141t
A e^-.141t + ●-X MINUS A e^-.141t
A e^-.0091t
Minutes

The mean observed plasma concentration-time curve of radiomercury for 15 subjects who received 'Mercuhydrin' intravenously. This curve is analysed graphically into its three exponential regression-rates. The sum of the three individual daughter curves at any time represents the total concentration of radiomercury in the plasma at that time expressed by the general equation, $C_p = A_1 e^{-b_1 t} + A_2 e^{-b_2 t} + A_3 e^{-b_3 t}$

large quantity (78 mgm.) of the element was administered. The third regression-rate is most likely primarily a reflexion of the elimination of the mercury from the body, principally urinary. This is supported by the fact that urinary excretion of radiomercury accounts for practically all this element lost from the plasma after 40 min. or so from the time of injection.

This analysis of the regression of mercury from the plasma of man is undoubtedly an over-simplification of multiple complex phenomena; but it serves as a basis for an understanding of other data dependent upon the concentration of mercury in the plasma. A more detailed discussion of the concentration-time course of radioactive mercury incorporated into a mercurial diuretic will appear elsewhere.

This investigation was aided by grants from the Life Insurance Medical Research Fund, a War Department Grant No. W-49-007-MD-389, and the Mrs. E. J. Caire Fund for Research in Heart Disease. One of us (J. P. M.) holds a National Institute of Health Post-doctorate Research Fellowship.

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Significance of the Enzymic Degradation of Cozymase in Living Organisms

Reason for the existence of a very potent enzyme system degrading cozymase in brain[1] and in certain other cells and tissues[2] has been obscure, as intact cozymase is so important to their normal functioning. The rate of breakdown by ground brain is of the order of 1 μmol./mgm. dry weight/hr.[1], whereas the rate of respiration by the intact tissue is about 0·5 μmol./mgm. dry weight/hr. Brain preparations split the cozymase molecule between the pyridine-N and ribose[1]. The results in Table 1 now show that the degrading enzyme can serve cellular economy in the following ways: (1) By decreasing the quantity of specifically the oxidized form of either coenzymes I or II in coenzyme-dihydrocoenzyme mixtures, their oxidation-reduction potentials can be expected to be lowered, and we have found this to be the case experimentally. (2) This can be expected to affect secondarily the many enzymes sensitive to changes in E_H. (3) The degrading enzyme will compete with dehydrogenases for the oxidized forms of the coenzymes, and in mixtures of dehydrogenases favour the action of those of greatest affinity for the coenzymes. (4) Equilibria at certain dehydrogenases can be expected to be modified by the additional presence of an enzyme which removes one component from the system of four which are typically involved. Thus the formation of β-hydroxybutyric acid would be expected to be favoured in the β-hydroxybutyric–acetoacetate system.

Table 1. Substrate specificity of the enzyme-degrading cozymase

Potential substrate (5×10^{-4} *M*)	Relative rate of degradation
Cozymase	100
Dihydrocozymase	< 0·5
Coenzyme II	65–80
Dihydrocoenzyme II	< 0·5
Cozymase with Dihydrocoenzyme II	90–100

These effects can be expected to influence the course of major reactions in most living systems in which the cozymase-degrading enzyme exists. In agreement with this, considerable changes in carbohydrate metabolism of brain slices have been found[3] to follow inhibition of this reaction by nicotinamide[4], nicotine, 5(4)-3′-pyridylglyoxaline[3] or phenosafranine[5]. The disturbances have included increases (up to ten-fold) in the rates of aerobic or anaerobic glycolysis. Phenosafranine was previously known to inhibit the Pasteur effect in mammalian tissues including brain[5], and some actions of nicotine[6] can be interpreted similarly. The specificity of action of these inhibitors is discussed elsewhere[3]. This evidence for the action of the degrading enzyme in normal tissues implies the existence also of active processes for resynthesis of the coenzymes[7]. The evidence of Judah and Williams-Ashman[8], that linkage between oxidation and phosphorylation in tissue homogenates is inhibited by concentrations of phenosafranine comparable with those of the present experiments, suggests that the degrading enzyme functions in aerobic phosphorylation. Its inhibition, leaving more inorganic phosphate and cozymase available for glycolysis than would otherwise be the case, would thus disturb the Pasteur effect.

Effects of the enzyme from the central nervous system on redox potentials can be very easily demonstrated by experiments of the type illustrated in Table 2. In this, dihydrocozymase to 10^{-4} *M* was added in Thunberg tubes to solutions containing the dyes of Table 2 in phosphate, *p*H 6·5, with a 1/30 dilution of a heart extract[9]; half the tubes contained a preparation of the cozymase-degrading enzyme from beef spinal cord (1·2 mgm. dry weight/tube, capable of degrading 3 μmol. cozymase/hr.). The enzyme had no effect on reduction of the positive methylene blue, but caused much greater reduction of the two negative dyes.

Table 2. Effects of cozymase-degrading enzyme on the degree of reduction of dyes by dihydrocozymase

Dyes	Percentage reduced	
	without enzyme	with enzyme
Methylene blue	>97	>97
Neutral red	20	86
Benzyl viologen	< 3	8

It is also interesting to observe that an enzyme which inactivates dihydrocozymase at a greater speed than cozymase has been observed in certain tissues, including intestinal mucosa[10]. This enzyme can be expected, by arguments similar to those advanced above, to raise redox potential. The coenzyme-degrading system in mammalian nervous tissue is associated with structures insoluble in physiological salt solutions[11] and can be expected to cause local differences in the concentrations of the coenzymes. It will be observed that several other enzymes exist which rapidly degrade other constituents[12] very important in normal cell economy, and that these can similarly be regarded as controlling group potentials[13]. In particular, adenosine triphosphatase shows many analogies with the cozymase-degrading system, and the two are, indeed, likely to have inter-related effects[14]. The possible connexions of these with the specific functions of nervous tissues are discussed elsewhere[15].

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*l-nor*Adrenaline in the Suprarenal Medulla

THE demonstration that *nor*adrenaline constitutes the specific neurohormone of adrenergic nerve fibres (sympathin N)[1] has directed attention to the occurrence of this substance in biological material. A recent contribution in this field is the report by Pamela Holton[2] that adrenal medullary tumours contain a high proportion of *nor*adrenaline. Normal suprarenal glands also contain *nor*adrenaline, as shown by Holtz[3]. The present report confirms these findings with the use of different techniques.

Suprarenal glands from cattle were extracted with 5 per cent trichloracetic acid and the acid removed with ether. The extracts were tested for the presence of *nor*adrenaline biologically by the blood pressure of the cat before and after 933 *F* and by using paper chromatography[4]. Quantitative determinations of *nor*adrenaline and adrenaline were made according to the method of Euler and Hamberg[5]. The latter method depends on the different *p*H-optima for the formation of adrenochrome and *nor*adrenochrome with iodine. At *p*H 4 and an oxidation time of 1½ min., the formation of adrenochrome is complete, whereas only approximately 7 per cent of the *nor*-adrenaline is oxidized. At *p*H 6 an oxidation time of 3 min. gives the sum of adrenochrome and *nor*-adrenochrome.

Extract	*nor*Adrenaline–HCl (μgm./mgm. fresh tissue)	Adrenaline–HCl (μgm./mgm. fresh tissue)
1. 49 gm. whole glands	0·68	1·80
2. 70 gm. " "	0·70	1·98
3. 500 gm. " "	0·48	2·16
4. 6·0 gm. medulla	2·68	11·3

The colorimetric method would not differentiate between *dl-* and *l-nor*adrenaline. The activity was therefore tested on the blood pressure of the cat and compared with adrenaline and *l-nor*adrenaline. Extract 2 was equivalent to 2·0 μgm. *l-nor*adrenaline per mgm., or 3·2 μgm. adrenaline per mgm. (ratio 1·6 : 1). The figures found colorimetrically would give $\frac{1{\cdot}98}{1{\cdot}6} + 0{\cdot}70 = 1{\cdot}94$ μgm. *l-nor*adrenaline activity on the blood pressure per mgm., which compares well with that actually found. After treatment of the cat with 933 *F*, which reversed the action of adrenaline but not that of *nor*adrenaline, a mixture of 2 μgm. adrenaline and 0·7 μgm. *l-nor*adrenaline gave the same picture as 1 mgm. extract and differed markedly from the effect of 3·2 μgm. adrenaline. Extracts 3 and 4 yielded similar results.

Paper chromatography with *n*-butanol saturated with *N* hydrochloric acid as solvent gave a close correspondence between the migration of a suprarenal gland extract purified by adsorption to alumina and a mixture of *nor*adrenaline and adrenaline (see accompanying illustration).

Paper chromatogram with acidulated *n*-butanol as solvent. (*c*) Mixture of *nor*adrenaline and adrenaline in proportion 1 + 2. (*b*) Extract of suprarenal gland purified by adsorption on alumina. (*a*) Mixture of *b* and *c*. Upper set of spots represents *nor*-adrenaline, lower set adrenaline

The presence of a sympathomimetic compound in suprarenal extracts with stronger blood-pressure action than adrenaline, such as *l-nor*adrenaline, is also indicated by the earlier results of Schild[6].

The present results show that the normal suprarenal gland from cattle contains *l-nor*adrenaline in appreciable amounts, as previously shown for adrenergic nerves. The results support Blaschko's concept of adrenaline formation in the chromaffine cells[7].

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Proteolytic Activity in Eggs and Sperms from Sea-Urchins

In studying the influence of water extracts from fertilized *Arbacia lixula* eggs upon unfertilized eggs, J. Runnström found that the jelly coat was attacked by the extract (unpublished). In order to examine this activity, extracts were prepared from fertilized and unfertilized eggs and also from sperm. The material was collected at the Zoological Station, Naples, in the spring of 1948, and the investigations started there and continued in Stockholm.

The material was lyophilized and the extractions carried out in the cold for six hours; afterwards it was dialysed for 24 hours against sea water. The activity was tested on gelatin and the effect measured in Ostwald viscosimeters at 35·5° C. The buffer capacity of gelatin was sufficient to maintain the *p*H during the experiment. The samples were made up of 1·00 ml. extract and 3·00 ml. of 4·0 per cent gelatin (Fisher Sc. granular, containing 0·005 per cent merthiolate) as sterilizing agent.

Extracts from eggs. As shown in Fig. 1, there is some proteolytic activity in the unfertilized egg; but

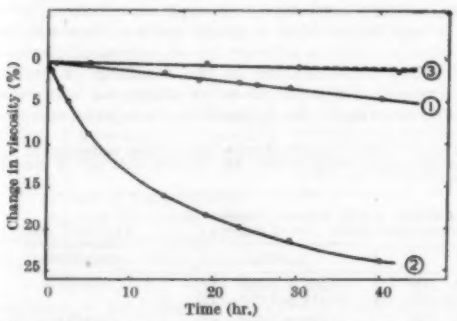

Fig. 1. Activity of egg extracts (*Paracentrotus*). (1) Unfertilized eggs. (2) Three minutes after fertilization. (3) Thirty minutes after fertilization. Control (extract 1 boiled 30 min.): dashed line. Initial concentration of dry matter 1·8 per cent. Temp. 35·5° C. *p*H 6·25

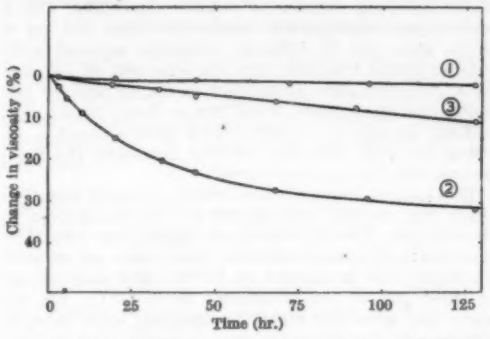

Fig. 2. Activity of sperm extracts. (1) *Arbacia* control (extract boiled 30 min.). (2) *Arbacia* extract. (3) *Paracentrotus* extract. Initial concentration of dry matter 5·0 per cent. Temp. 35·5° C. *p*H 6·45

three minutes after fertilization the activity is stronger than in unfertilized eggs. Thus it can be assumed that after fertilization there is liberated in the egg a proteolytic enzyme (or complex of enzymes) taking part in the processes occurring after fertilization; but after a brief time the activity of the enzyme is abolished. The activity exhibited by extracts from unfertilized eggs is perhaps due to activation during the freezing or the extraction.

Extract from sperms. Fig. 2 shows the activity of two different sperm extracts, one from *Arbacia*, another from *Paracentrotus lividus*. The former is more active than the latter. It is not yet established whether this depends upon a lower concentration of the enzyme, or on a lower rate of extraction in the *Paracentrotus* sperm.

A full report of this work will appear elsewhere. I wish to express my gratitude to Prof. J. Runnström for suggesting the subject.

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Effect of Humidities and Temperatures on the Size and Number of Oocysts of *Plasmodium gallinaceum* Transmitted by a Mosquito

Mosquitoes need a certain amount of moisture in the atmosphere in which they live. From the investigations of earlier workers[1], we find that changes in the humidity influence the longevity of the insect host and consequently that of the parasite within; low, as well as very high, humidities are detrimental. But if a mosquito is infected with the malaria parasite (*Plasmodium*), the size of the oocysts is not influenced by atmospheric humidity. As to the number of oocysts, according to Gill's work, this is not influenced either. In the work done here, *Aedes ægypti* were fed on chicks infected with *Plasmodium gallinaceum*, and the speed and degree of development of oocysts in the mosquito under various climatic conditions were studied.

Method and technique. In these experiments the mosquito was looked upon solely as the medium in which the parasite grows. Jars containing sulphuric acid and water in various proportions were used to

obtain varying degrees of relative humidity. In a preliminary experiment, mosquitoes just fed on a chick were put in celluloid cylinders covered with netting inside the jars. At temperatures of 18° and 25° C., and relative humidities of 50, 60 and 70 per cent, most mosquitoes lived five or more days; this is long enough to allow oocyst development. At either 30 or 90 per cent relative humidity the mosquitoes died in a short period.

In a second series of experiments, a highly infective chick was chosen, and offered to the mosquitoes in their cages. Twenty engorged mosquitoes were then placed in cylinders inside the jars. One jar at each humidity was incubated at 25° C., and another set of three jars in the laboratory at ± 18° C. On the sixth day after the meal the numbers alive were as follows:

	18° C.			25° C.		
Relative humidity	50	60	70	50	60	70
Mosquitoes	12	17	15	13	16	14
Oocysts, mean	10·92	28·76	28·80	11·00	33·25	32·06

These were dissected, the number of oocysts and their size measured in each individual mosquito. The results are shown in the bottom line of the table.

As regards the size of these oocysts, they did not seem to vary much, though those kept at 18° C. were on the average smaller than those at 25° C. Measurements ranged between 15·8 and 17·6 μ at 18° C., and between 18·5 and 20·2 μ at 25° C.

Discussion. Humidity does not affect the speed of development of oocysts (which is affected by temperature); but it clearly affects the number of oocysts which develop, a low humidity being associated with a smaller number of parasites.

One might perhaps think that a low humidity would kill the most heavily infected mosquitoes, because the plasmodial infections might have injured them. But this explanation is ruled out, for the figures do *not* demonstrate a particularly high mortality at the lowest humidity which I used (50 per cent). One is left to suppose that at the lower humidity the increased evaporation from the insect must have altered the blood or tissues of the mosquitoes and had an unfavourable effect on the development of the parasite. It should be stressed, however, that conditions in this experiment differ from those met with in Nature, where the mosquito might be able to get access to drinking water however low the relative humidity of the environment might be. In this sense the results are only of academic interest and should not be applied to natural conditions.

The effect of temperature in my experiments only shows that at high temperatures (25° C.) the rate of growth of oocysts is faster than at lower temperatures (18° C.). The size of oocysts at 25° C. is always larger, although both batches of mosquitoes were fed on the same bird on the same day.

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Analysis of Heteroploidy Produced by Chloracetophenone

The problem of demonstrating and analysing the degree of ploidy of non-dividing cells is continually arising in different contexts, for example, in cancers, or giant cells in tissue culture. Chromosome counts may not be available in such material, and recourse must be had to indirect methods such as those reviewed by Fankhauser and Humphrey[1], including measurement of cell and nuclear volume, nuclear spacing, projected areas of uncountable mitotic figures, counts of heterochromatic spots and maximum number of nucleoli. Huskins demonstrated polyploidy in non-mitotic plant cells by inducing them to divide with 3-indole acetic acid and counting chromosomes. None of these methods except Huskins's[2] are entirely independent of prior study in the same material of tissues of known degrees of ploidy, and one of the most reliable methods (maximum number of nucleoli) breaks down when applied to limited material or to mixed tissues of varying ploidy. The interesting paper of Biesele, Poyner and Painter[3] utilizes and reviews indirect methods in respect of polyploidy and the related condition of polyteny in mouse cancers, but on plentiful material and with the assistance of chromosome counts.

The necessity of finding a reliable indirect method was encountered while examining tail-tip preparations of *Rana temporaria* tadpoles which had been subjected at the gastrula stage to 5×10^{-4} *M* chloracetophenone. In untreated tadpoles, the nuclei of pigmented and unpigmented epidermal cells are thin disks of equal mean projected area. In treated tadpoles the unpigmented cells are unaffected: the pigmented cells and nuclei, however, although normally differentiated, were giant and non-mitotic, and some cells were polynucleate. For various reasons the indirect methods referred to above were all impracticable or inconclusive; at least pentaploidy was indicated (maximum number of nucleoli five), and cell and nuclear size suggested a degree of heteroploidy between tetra- and octoploid.

It was found that a much more precise analysis of ploidy could be effected by an empirical approach involving consideration of the numbers of nucleoli and their projected areas as measured on *camera lucida* drawings. Six types of nucleus were examined

Table of mean nucleolar areas in epidermal cells of *Rana* tadpoles. Projected areas of nucleoli measured in cm.² under linear magnification 1,780. For each mean a preliminary analysis (where relevant) gave no significant differences within nuclei. Age counted from day of treatment (gastrulation)

Group	Type of cell	Number of nucleoli per nucleus	Mean area per nucleolus ± S.E. of mean: number of nucleoli measured in brackets. Age of tadpoles: 4-day	8-day	Combined mean nucleolar area (unweighted)
I	Diploid	2	0·123 ± 0·021 (16)	0·109 ± 0·006 (14)	0·11
	Giant	4	0·101 ± 0·007 (16)	0·111 ± 0·007 (12)	
II	Giant	3	0·146 ± 0·011 (18)	0·136 ± 0·008 (9)	0·14
III	Diploid	1	0·240 ± 0·025 (8)	0·220 ± 0·031 (7)	0·22
	Giant	2	0·180 ± 0·017 (16)	0·245 ± 0·022 (16)	
IV	Giant	1	0·355 ± 0·030 (4)	0·464 ± 0·025 (10)	0·41

in uninucleate cells, namely, normal diploid (unpigmented) cells with either one large or two small nucleoli per nucleus, and giant (pigmented) cells with one, two, three or four nucleoli per nucleus. The mean areas of the nucleoli in each type of nucleus were determined in two tadpoles of different age, as shown in the table. *t*-Tests show that the data for each tadpole fall into four groups; means in any one group differ from means in other groups; means within a group do not differ. The only exception among the various comparisons is that Group II in the 4-day tadpole does not quite attain a significant level of difference from the highest member of Group I and the lowest of Group III.

As well as falling into groups, the data also indicate a simple and striking proportion between nucleolar areas. The total nucleolar area (that is, the product of mean nucleolar area and number of nucleoli per nucleus) is uniformly about twice as great in giant nuclei as in diploid nuclei. These results can only be explained by a condition of tetraploidy in the giant cells. The combined areas in the last column for Groups I, II, III, IV are close to the $1 : 1\frac{1}{2} : 2 : 4$ proportion, which would be expected in such circumstances.

One of the only two 5-nucleolate nuclei was present in one of these tadpoles: the nucleoli approximated closely to two of Group I size and three of Group III size, indicating, therefore, octoploidy.

In the light of these results, cell and nuclear areas which had been measured in these and sixteen other tadpoles could now be interpreted; the mean areas were much the same in all tadpoles, and the effect of chloracetophenone was therefore of general occurrence. In addition, some analysis of polynucleate cells could be made; for example, cells with two tetraploid nuclei were found, and the occasional presence of small non-nucleolate nuclei indicated the occurrence of aneuploidy.

It is thus possible to state with some certainty that chloracetophenone applied to frog gastrulæ gives rise in the tadpole to epidermal cells which are mainly tetraploid, together with some octoploidy, aneuploidy, and combined heteroploidy and polynuclearity. This is interpreted as evidence of interference with the spindle mechanism.

As the method of determining ploidy is purely empirical, based on differences and identities in the data, it may well prove of some general use. The fact that a simple proportion existed between total nucleolar area in a nucleus and the degree of ploidy was a fortunate accident which simplified the interpretation; but the demonstration of tetraploidy in Groups I and III at least would be unaffected by a more complicated proportion such as might occur in other material.

Chloracetophenone is known to be a specific inhibitor of all enzymes the action of which depends on —SH groups[4]; the bearing of this on the production of heteroploidy and other effects in Amphibia is at present under investigation.

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Cytoplasmic Bud Formation in Hymenopteran Spermatogenesis

Many early workers on hymenopteran parthenogenesis describe the formation of a cytoplasmic bud and its pinching off during the first spermatocyte abortive division. Earlier observations were tabulated by Sanderson[1], to which may now be added the following:

Group	Species	Abortive division	Authority
Braconidæ	*Habrobracon juglandis*	Bud pinched off	Torvik-Greb[2]
Cynipidæ	*Neuroterus baccarum*	No bud pinched off	Dodds[3]
Ichneumonidæ	*Aenoplex smithii*	Bud pinched off	Koonz[4]
Ichneumonidæ	*Spilocryptus extrematus*	Bud pinched off	Koonz[4]
Tenthredinidæ	*Diprion polytomum*	No bud pinched off	Smith[5]
Sphecoidea	4 species	No first division	Whiting[6]

The phenomena have often been discussed from an evolutionary point of view, White[6] expressing the situation thus: "The functional significance of these cytoplasmic phenomena is far from clear. The bees are morphologically the most 'highly evolved' group of the Hymenoptera but they have preserved a remnant of the first meiotic division that has been lost in the far more primitive sawflies. Yet when we come to the second meiotic division the bees seem to have acquired a specialized mechanism whereby the cytoplasm is unequally distributed to the two spermatids one of which is functionless."

In sawflies (Tenthredinidæ) Sanderson[1] was unable, despite repeated search, to be satisfied that such cytoplasmic buds were freed, stating: "Appearances would indicate that cytoplasmic buds are freed, but closer examination reveals that these bodies are merely sections through the cytoplasmic bridges by which the spermatocytes are bound together, the 'Zellkoppelungen' and 'Interzonal bodies' of German and American authors respectively."

The seeming anomalies in Hymenoptera therefore led me to devote great attention to these buds during studies on spermatogenesis in the sawfly *Pteronidea ribesii*. In sections it is extremely difficult, if not impossible, to say with certainty whether the 'buds' are sections of bridges or not. With mounts of fresh material, however, this doubt can be resolved, for one of the most striking appearances in a mount of testis at the maturation stage is the number of free anucleated cytoplasmic buds. Examination of unruptured cysts clearly shows that these buds are

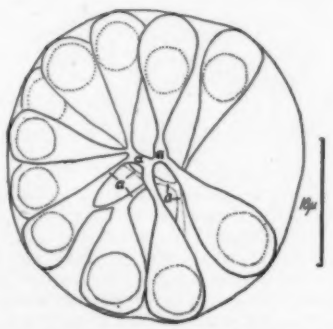

Fig. 1. Cyst of pear-shaped first spermatocytes at interkinetic stage. *a*—Cytoplasmic bridges

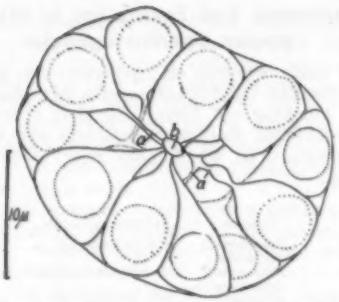

Fig. 2. Cyst of first spermatocytes about prophase stage. *a*—Cytoplasmic bridges, *b*—adherent bud

present in large numbers in cysts of spermatids but are few at the anaphase and metaphase of the second division and, except in a few cysts, are not found before this division.

Whether a bud is freed or not at the end of the abortive (first) division can in my opinion be satisfactorily interpreted for *Pteronidea ribesii* as follows.

The first spermatocytes are roughly pear-shaped and have their apices directed toward the centre of the cyst, the cells being connected by cytoplasmic bridges containing the 'interzonal' or 'cell-coupling bodies' (Fig. 1). At prophase and metaphase the cell shape is more rounded, or even spherical if space allows, and the cytoplasmic bridges appear as in Fig. 2. It would seem that the substance of the 'interzonal body' is more viscous than the cytoplasm of the cell body, so that the rounding of the cells causes the bridges to become more attenuated, some occasionally breaking and causing the formation of buds attached to the cells and containing the 'interzonal body' substance. The axis of the abortive spindle is usually radial, and at telophase there is a slight elongation of the cells along this axis so that they once more become predominantly pear-shaped

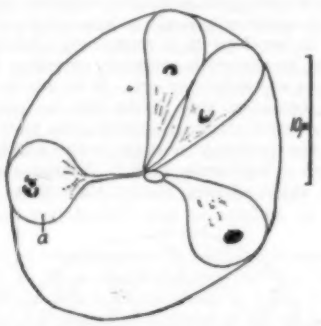

Fig. 3. Cyst showing three cells at abortive telophase stage and cell 'a' more advanced and entering second metaphase stage

(Fig. 3). The changes indicated in Fig. 4, *a–d*, have been observed when a cell with a cytoplasmic bud once more is connected with other cells, re-forming cytoplasmic bridges at the telophase of the abortive division. The telophase chromosome clump resolves itself into the chromosomes of the second metaphase plate, and the cell once more rounds itself as far as space in the cyst allows. This rounding is far more pronounced than in the first division, and therefore causes the rupture of more cytoplasmic bridges and

Fig. 4. Successive stages of a cell from anaphase, *a*, to telophase, *d*, of abortive division, showing cytoplasmic bud in *a* eventually bifurcating in *d* to reform cytoplasmic bridges with two other cells

the consequent appearance of quite a number of cells at the metaphase stage with cytoplasmic buds (Fig. 5) adherent. The axis of the second division is at right angles to the first division spindle, and therefore at approximately right angles to the cytoplasmic bridge process or bud. The elongation of the cells at anaphase and their subsequent cleavage into spermatids result in the separation of some of these cytoplasmic buds or in spermatids with buds adherent (Fig. 6).

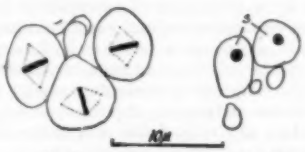

Fig. 5 Fig. 6

Fig. 5. Cells at metaphase of second division, two with buds
Fig. 6. Free buds from cyst of spermatids, two shown adhering to spermatids, *s*

Meves and Duesberg[9], regarding *Vespa crabro*, in opposition to Mark and Copeland (who find the buds to be freed at the beginning of metaphase), state that they find the buds attached to the mother cell at anaphase of the second division. From Meves and Duesberg's description and drawings, and from Meves's[10] observations on the honey-bee, I conclude that the above interpretation might also explain their findings.

The formation of cytoplasmic buds, freed or not, during maturation divisions, at least in the sawfly *Pteronidea ribesii* if not in other and more highly evolved Hymenoptera, can, I think, be more satisfactorily interpreted as the result of the 'sticky' property of the cell coupling (interzonal) body interfering with the mechanics of cell division during the rounding of the cell at metaphase, and has not the evolutionary significance commonly attributed to it, namely, that it is a remnant of cytokinesis.

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Identity of the Shell Pigment of *Haliotis cracherodii* Leach

In 1903 Schultz directed attention to the blue, acid-soluble pigment which occurs in the shells of the Californian abalone. Subsequent studies by Schultz, Schultz and Becker[1], Kodzuka[2] and Lemberg[3] have further subdivided the pigments present; but there has been no agreement as to their identity. Schultz, in his later papers, pointed to the similarity between the visible absorption band of the main pigment ($\lambda_{max.}$ 622 mμ) and that of the known indigos, and Lemberg identified the pigment provisionally as a pyrrole body, since its solubility in dilute acids is greater than that of most indigoids. The pigment is known to give a strong colour reaction with nitrites and with fuming nitric acid. There has been doubt about the exact nature of this reaction, and about the number of pigments responsible for it.

Using a technique of chromatography on talc, and starting with acid extracts (in 2*N* hydrochloric acid) of shells of *Haliotis cracherodii*, of which Schultz's *H. californiensis* is a variety, we have obtained clear-cut separation of the pigments on the column into a lower green, brown and violet series, some of which give reactions typical of bilitrienes, and a main blue fraction corresponding to Lemberg's pigment *B*. We further purified this main pigment by chromatography of amyl alcohol extractives from the original acid solution, and produced a homogeneous fraction which could not be resolved on the column. Details of this preparation will be published elsewhere.

The reaction of the blue pigment with nitrite is not typical of Gmelin's bilitriene reaction; it is, however, closely similar to that given by indolylacetic acids (Nencki–Sieber test), and the amyl alcohol-soluble product of the reaction gives a visible absorption, plotted on the Beckmann spectrophotometer, which resembles that recorded for the urorosein pigments by Homer[4], by Watson[5], and by Rimington, Holiday and Jope[6].

Haliotis derivative		Urorosein (Watson[5])
Ammonium hydroxide:	522–492	555–557 mμ
Hydrochloric acid:	559–550, 540–490	544, 511

Urorosein from indolylacetic acid (Homer[4])
552–531, 505–492
from indolylaceturic acid
579–539, 502–485

In view of these findings, a specimen of the blue pigment in chloroform–cyclohexane was examined for fine structure in the ultra-violet region, using a Hilger medium quartz spectrograph and a hydrogen arc source, and the resulting bands compared with those of indigotin. The following results were obtained:

	Haliotis blue	Indigotin
Bands $\lambda_{max.}$ (A.)	3570	3560
	3370	3370
	3226	3210
	3070	3070
	—	2856
	—	2745

These results confirm the view of Schultz and Becker[1] that the pigment is closely related to indigotin, and is not a pyrrole; in its solubilities it differs considerably from the known indigos, being considerably more soluble in aqueous acids even than the N—N′ dialkyl indigos. Details of its behaviour, and of the concomitant pigments, will appear elsewhere.

The finding is of interest in view of the occurrence of substituted indigos in the eggs and hypobranchial gland of many Stenoglossa. Pigments of this type have not previously been detected in the lower gastropods.

Acknowledgment is due to Prof. C. Rimington for his kindness in providing access to the Beckmann spectrophotometer, and to E. M. Jope, of the London Hospital Spectrographic Department, for examining and reporting on the ultra-violet spectrum of the substance.

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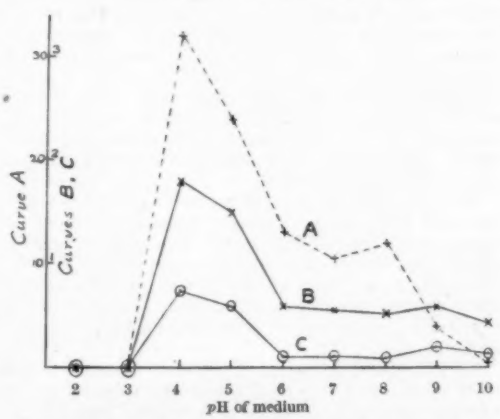
Germination and Development of Heather and the Hydrogen Ion Concentration of the Medium

Several workers[1-3] have shown that, in the field, heather (*Calluna vulgaris* Salisb.) is found most frequently and attains its maximum development on soils the reactions of which are about *p*H 4. I have examined the germination and the subsequent seedling development of *Calluna* seeds planted on agar media adjusted to give a range of reactions. A quantity of 1 per cent British agar was prepared with a form of Knop's solution. This was divided equally between nine flasks. The contents of these were adjusted to *p*H 2, 3, 4, 5, 6, 7, 8, 9 and 10, respectively, by the addition of the requisite quantities of sulphuric acid or caustic soda. After adjustment, the agar in each flask was poured into six 1-in. boiling tubes to give a depth of agar of about 1½ in. The tubes were plugged and the agar allowed to set. A liberal sowing of *Calluna* seeds was then made in all tubes.

After six weeks, germination was found to have occurred in all the cultures, although, in most cases,



Number and dimensions of seedlings of *Calluna vulgaris* in relation to *p*H. (*A*) Mean number of seedlings; (*B*) average of mean shoot-lengths (cm.); (*C*) average of mean root-lengths (cm.)

it had not proceeded beyond the stage of emergence of the radicle. Seven months after sowing, the seedlings in each tube were counted; also, the lengths of roots and shoots were measured. The means of these data for the six tubes at each reaction are plotted against *p*H in the accompanying graph. The bimodal form of curve *A* is clear, and a tendency to the same is perceptible in curves *B* and *C*. Others have observed this phenomenon in studies of the relations of various species to hydrogen ion concentration.

This experiment, which was performed in the Botany Department at the West of Scotland Agricultural College, confirms the field evidence that the optimal reaction for *Calluna* is in the region of *p*H 4. Above this level, not only do the germination of seeds and the growth of seedlings decline, but also chlorosis is progressively more marked. Even at *p*H 5, severe chlorosis of the tips occurred. Local rises in soil reaction might thus account for the frequent appearance of chlorotic heather plants in the field.

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Occurrence of a Species of *Clymenella* Verrill (Polychæta, fam. Maldanidæ) on the North Kent Coast

McIntosh[1] states that "the representatives of the Maldanidæ are met with but seldom in British waters, and in the majority of instances only fragments are secured". In fact, a study of the literature reveals that many species, and even genera, are described from preserved material, often in a fragmentary condition. It is of interest to record, therefore, that a fairly large maldanid is moderately common in the intertidal zone at Whitstable near the ordinary low-tide mark.

The worm belongs to the genus *Clymenella* Verrill, and this is, so far as I can find out, the first record of a member of this genus occurring on the coasts of Britain, or, for that matter, on the coasts of Europe. Fauvel[2], it is true, describes a *Clymenella* (?) *cincta* from Manche (Dinard), but notes that "Cette espèce n'étant connue par un seul fragment antérieur de 12 sétigères, il n'est pas possible, vu l'absence de la région postérieure, de préciser exactement à quel genre elle appartient".

Monro[3], in discussing the genus *Clymenella*, points out that there are two groups of species included in that genus, "the *torquata*, *rubrocincta*, *somersi* and (?) *elongata* group, with anterior *uncini* differing little, if at all, from their normal *uncini*, and the *minor*, *cincta* south-west Australian and Indian Ocean *Clymenella* sp. group, with anterior ventral *acicular hooks*".

The maldanid found at Whitstable clearly belongs to the *torquata* group and more closely resembles *Cl. torquata* than any other species. It may prove to be a new species; but this cannot be decided until a comparison has been made with specimens of *torquata* obtained from America.

Clymenella torquata and its allied species are reported solely (?) from the coasts of North America, and it is possible that the Whitstable maldanid may prove to be a recent immigrant comparable in this respect with *Urosalpinx cinerea* and *Crepidula fornicata*.

A description of the worm is in course of preparation.

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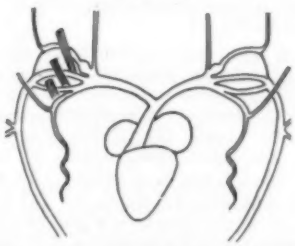
Persistent Fifth Arterial Arch in the Frog

A rare abnormality in the arterial system of the common frog was found in a male specimen from Cornwall. The fifth aortic arch persisted on both sides of the animal and was patent. Carotid, systemic and pulmo-cutaneous arches were normal; but the fifth arch branched off from the pulmo-cutaneous. It joined the systemic arch laterally and was large and open. Right and left sides were symmetrical. A ligamentum aortico-carotideum was present. The relation of the posterior petro-hyoideus muscles was as follows. The internal carotid artery slipped beneath, that is, dorsal to, the first petro-hyoid muscle, the systemic arch dorsal to the second, and the abnormally persistent arch dorsal to the third, thus preserving the regularity of arrangement which is lost when the fifth arch disappears during development.



Rana temporaria. Male. Heart and arterial arches. The left carotid, systemic, persistent fifth and pulmo-cutaneous arches are shown, with the ligament connecting the internal carotid artery and the systemic arch. The right arches are similar, and the first, second and third posterior petro-hyoid muscles have been drawn in position

So far as I am aware the abnormality described has not been recorded on *both* sides of an adult frog. O'Donoghue[1] gave an account of a persistent fifth arch on the left side of a male, without reference to the musculature, and in his specimen a true ductus caroticus was present.

Abnormalities in the venous system are much more common, and among this group of a hundred frogs three exhibited persistent lateral abdominal or posterior cardinal veins.

N. B. Eales

University of Reading.
March 7.

[1] *Anat. Anz.*, **75**, No. 21/22 (1933).

A NEW TYPE OF BETATRON WITHOUT AN IRON YOKE

By A. BIERMAN

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BY far the most expensive and the heaviest part of betatrons, as usually constructed, is the iron yoke with its complicated pole-pieces. We propose to describe a mode of construction which uses no yoke, and which, though restricted in its applications, offers several important advantages over the original type of betatron.

The main features of our betatron are two coils in series, with a sealed-off glass acceleration tube between them. The dimensions are chosen so as to fulfil the well-known condition $0 < n < 1$, n being determined by the radial decrease of the magnetic field, which is assumed to be proportional to r^{-n}. The flux required within the electron orbit is attained by means of a small iron core placed in the axis of the coils. This iron core is inserted inside the 'Pertinax' tube, visible in the photograph. Saturation of this core effects contraction of the orbits towards the end of an acceleration period, until the electrons strike a tungsten target 0·1 mm. thick. The core, made of transformer sheet-iron, is interrupted half-way by a small gap which is so adjusted that the contribution of its stray field makes $n = \frac{1}{2}$ over almost the entire area of the electron orbits.

The dimensions of the tube are hence not restricted by pole pieces, and have been made very large. The inner wall of the tube is covered with a transparent, fluorescent semi-conductor, which has proved valuable for investigating the behaviour of the electron beam at different magnetic field-strengths and the effects of parasitic fields. Moreover, the transparency of the tube is very convenient for the glass-blower, while the electron gun and the target are being sealed into their precise positions. The electron gun is small both in the axial and radial direction; hence its chance of being struck by electrons is less than with the usual type of construction.

If simplicity of equipment is desired, we may forgo the advantage of short-pulse injection and take a sinusoidal injection voltage from an auxiliary coil placed on the axis of the main coils (shown on the left of the photograph). The tension induced in this coil amounts to several kilovolts, from which the injection voltage can be tapped off at various points.

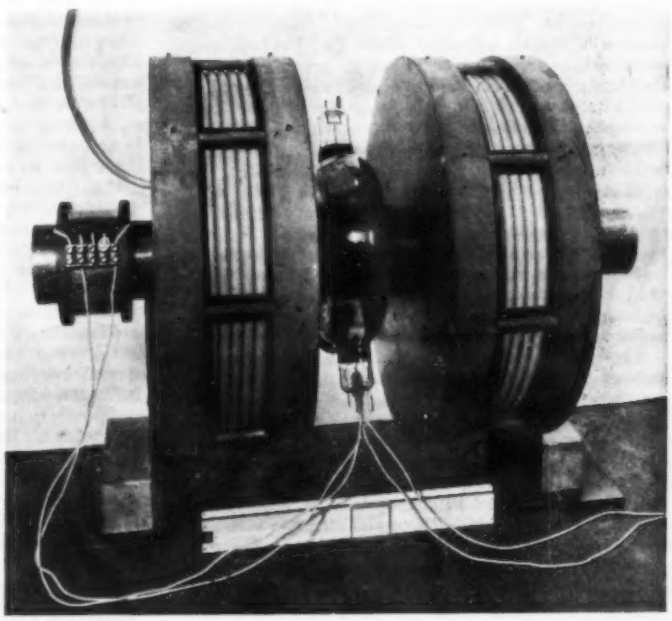
The current through the coils is supplied by discharging a 6·5 μF. condenser via a spark gap. The condenser is continuously loaded from a rectifier, and the spark gap breaks down as soon as the voltage across the condenser reaches a value of about 50 kV., so that the discharges are automatically repeated at intervals of a few seconds. It is also possible to arrange for a single discharge at a fixed moment, as is, for example, required for Wilson camera exposures.

Each discharge initiates damped oscillations with a frequency of 2,500 c./sec., in which the peak current through the coils attains a value of about 5,000 A. The power needed to maintain undamped oscillations would, with the present construction, be several thousand kilowatts, which makes continuous operation impossible because the dissipation would then be far too high. The small apparatus, shown in the photograph, is therefore only capable of producing radiation pulses at intervals of at least one second. Since after a few complete oscillations the current has been so much reduced that the iron core is no longer sufficiently saturated, only a few periods can be utilized in each discharge.

Though the mechanical forces resulting from the very heavy currents demand a solid construction of the coil frame, the betatron as a whole weighs no more than 50 kgm., the iron core itself weighing less than 5 kgm.

As the peak value of the magnetic field is 0·4 V.sec./m.^{2} (4,000 gauss) and the radius of the orbit is 8 cm., the energy of the accelerated electrons amounts to 9 MeV. This value can be reduced by exchanging the core for a smaller one which is saturated at lower currents; the contraction of the electron orbits will then take place at an earlier phase of the discharge. In this case a greater number of periods are utilized in each discharge.

It will be clear that in experiments requiring short-wave X-ray output during a brief period (as, for example, nuclear processes investigated with a Wilson camera) this type of betatron offers distinct advantages. Its simple construction makes the cost low, and it is light enough to be comparatively easy to handle;



9-MeV. betatron without an iron yoke. Slide-rule against base gives the scale

it can, for example, be mounted on a mobile support. Moreover, the intensity of the radiation produced is greater than with the customary betatrons, for several reasons: because of the high frequency, the energy-gain in each loop is considerable (240 volts); this effects strong damping of the oscillations about the equilibrium orbit, while, moreover, the total path of the electrons is not more than 30 km. Consequently the loss of electrons by impact against the wall or against the molecules of the residual gas is considerably smaller than at the lower frequencies commonly used. In addition, a greater number of electrons can be accelerated at a time, owing to the large dimensions of the acceleration tube. Lastly, the axial symmetry of the magnetic field is more perfect than in an apparatus with pole pieces arranged in sectors, which again reduces the loss of electrons. Reliable data on the intensity of the radiation are not as yet available, but our experiments have already yielded evidence that the peak intensity is much higher than that obtained, in this laboratory, with a betatron of the customary type.

MULTIPLICATION AND DIVISION BY ELECTRONIC-ANALOGUE METHODS

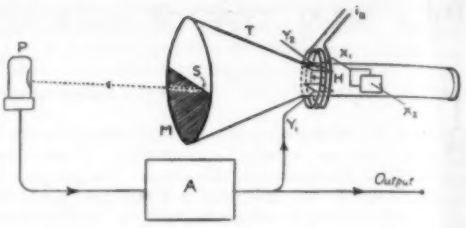
By E. M. DEELEY and D. M. MACKAY
Wheatstone Laboratory, King's College, London

THE product or quotient of two rapidly varying quantities is difficult to obtain by conventional electronic-analogue methods. Desirable features in a multiplier include: (*a*) symmetry of response to positive and negative inputs; (*b*) an *absolute* indication of zero input, with consequent freedom from zero drift; (*c*) independence of normal changes in electronic characteristics; (*d*) rapidity and accuracy of response.

Techniques such as amplitude-, frequency- or pulse-modulation adapted from the field of communications have so far failed to provide all these features; most are fundamentally incapable of doing so. The object of this note is to direct attention to a simple principle which has been found to meet the above requirements[1], and which seems to invite wider application in this and related fields.

It is most easily described as a development of the principle used in J. J. Thomson's familiar method of measuring electron velocity, in which the force on an electron moving with velocity v at right-angles to a magnetic field H is counteracted by an electrostatic field E proportional to the product $H \times v$. If the adjustment of E were automatic and instantaneous, its value would be a continuous measure of this product.

The cathode-ray tube, which is well known to possess potentially all four virtues above, forms a convenient basis for experimental work. In Thomson's arrangement, however, v was the axial velocity of the electron stream, which is not a widely variable or reversible quantity. Accordingly, in the practical form of multiplier shown in essentials in the accompanying diagram, an axial magnetic field is used and v is the *transverse* velocity of the electron stream in the X-direction, proportional to a voltage V_x applied to conventional deflecting plates X_1, X_2. After X-deflexion, the stream passes through the magnetic field H, which produces a deflecting force, initially in the Y-direction, proportional to $H \times V_x$.



The Y-deflexion of the spot S on the screen, which would normally result (corresponding to a rotation of the pattern), is counteracted by a photo-electric feedback system of the type used in function-generators[2,3]. The photocell P, coupled to one of the Y-plates via the amplifier A, prevents the spot from deviating by more than a fraction of its diameter from the edge of the mask M. With care in adjustment of the latter, the spot can thus be held closely to the X-axis, and V_y is then proportional to the product of V_x with the current i_H producing H. Conversely, if the photocell is used to control H and voltages V_x, V_y are applied to X and Y plates, the current i_H is proportional to the quotient V_y/V_x.

Since the important parameters other than the accelerating voltage are purely geometrical, the prospects of attaining high stability in a device of this kind are good. Output is sensibly independent of changes in the gain of A, as usual in feedback circuits. At a later stage, it is hoped to dispense with the photo-electric link, using a collecting-electrode inside the tube to perform the combined function of cell and mask.

At the time of writing, it has not been possible to make a fair test of the accuracy and frequency-range of the technique; but it may be of interest to summarize the encouraging results of preliminary experiments with quite crude apparatus. A 931—*A* photomultiplier has been used, with a cathode-ray tube having a blue screen and running at only 500 V. to enhance overall sensitivity; D.C. and sinusoidal inputs up to 10 kc./sec. have been multiplied over the ranges $\pm$ 300 mA. and $\pm$ 20 V., with an accuracy of the order of 2 per cent at 50 c./sec.

Accuracy is limited in practice fundamentally by the signal to noise ratio attainable in the feedback path. Other important factors are the uniformity of the axial field, and its effective axial length, which should not greatly exceed that of the Y-plates. If magnetic X-deflexion were used, the Y-voltage would be practically independent of 'gun' voltage; but if electrostatic X-plates are employed for the sake of their high impedance, the output is directly proportional to the square root of the gun voltage, the stability of which is then an important factor in overall accuracy.

The importance of such devices to the physicist and mathematician lies chiefly in their application to the solution by analogue methods of differential equations with non-constant coefficients. A number of further applications of the same principle to high-speed electronic computing technique are being developed, and a fuller account of these and the above will be published elsewhere.

[1] MacKay, D. M., Brit. Prov. Pat. Spec. No. 11161 (1948). The same principle has been the subject of an unpublished independent investigation by D. J. Mynall.
[2] MacKay, D. M., *Nature*, **159**, 406 (1946).
[3] Mynall, D. J., *Nature*, **159**, 743 (1946).

THE SMITHSONIAN INSTITUTION

REPORT FOR 1946–47

THE annual report of the Board of Regents of the Smithsonian Institution for the year ended June 30, 1947,* has now been published as a bound volume, including, besides the secretary's report and that of the executive committee, reports on the United States National Museum, National Gallery of Art, Freer Gallery of Art, Bureau of American Ethnology, International Exchange Service, National Zoological Park, Astrophysical Observatory, National Air Museum, Canal Zone Biological Area, and the Institution's library and publications. In a general appendix are reprinted a series of papers, some original, ranging over such diverse subjects as large sun spots, atomic energy, the use of isotopes as tracers, silicones, new products of the petroleum industry, drowned ancient islands of the Pacific basin, the biology of Bikini Atoll, the senses of bats, the influence of insects on human welfare, mosquito control tests, the primary centres of civilization, and the performance of propeller and reaction-propelled aeroplanes.

The reports from the National Air Museum and the Canal Zone Biological Area are the first to be included since these came under the administration of the Institution. The former, established in August 1946, is concerned mainly with the acquisition of a storage depot for the temporary assembly of material for the Museum. The latter includes the biological laboratory on Barro Colorado Island, which has already been responsible for much valuable scientific work. Some account of this work during the past twenty-four years is included in the present report. Studies cover the testing of wood for proofing against termites, the tropical deterioration of plywoods, textiles and packaging containers, and the effect of fungi on optical glass. Biologists go to the island regularly to study the fauna and flora, and there is a herbarium of 1,533 mounted specimens, as well as a species index containing about 7,000 entries. In addition to rainfall, temperature and relative humidity observations for 1946, the report records trials demonstrating the possibility of using treated timbers to build a termite-free house even where termites are extremely abundant and active.

Nearly 757,000 specimens went to the United States National Museum during the year, including two large and outstanding collections of fishes; but one of the most promising features of the year's work was an opportunity to resume field investigations of fifteenth-century historic Indian village-sites and some of the early Spanish settlements in the West Indies. Field studies were also made in Guatemala on the highland Maya for comparison with the lowland Maya of Yucatan; a survey of the fishery resources of Guatemala was continued and a botanical survey made of St. Vincent. The Bureau of American Ethnology continued the River Basin Surveys instituted in 1945 to recover archæological and palæontological information and materials which would be lost through the construction of dams and large reservoirs in many of the river valleys of the United States. Surveys in the Missouri Basin have been followed by others in Georgia, Virginia–North Carolina, Texas, California and the Columbia–Snake basin, while other investigations related to Eskimo anthropology, an Arctic Bibliography and Roster, the social organisation and ceremonial life of the Seneca nation, and cultural affinities between the northern Iroquoians and the Cherokee of the Great Smoky Mountains. Packages received by the International Exchange Service for transmission increased by 163,296 to 703,798, and the lag due to the War has been decreased to 69,020 lb. Consignments are forwarded to all countries except Roumania and Yugoslavia.

A slight improvement in the supply of animals for exhibition enabled the National Zoological Park to replenish the stock; but although some physical improvements were made, the Zoo was still understaffed. A list of additions and of animals, birds and reptiles in the Park is appended. The Division of Astrophysical Research was concerned first with appraisal of the solar constant values received from its field stations, with planning and developing improvements in instruments and methods, and with Camp Lee measurements of sun and sky radiation. The Division of Radiation and Organisms concentrated its work on the role of light, especially the wave-length effects, on the fixation of carbon by green plants, and on the influence of light on plant growth and development, particularly the mechanism of dormancy in light-sensitive seeds and the developmental physiology of grass seedlings. Of 62,137 accessions to the library, 14,607 went through the International Exchange Service, and 1,693 books were purchased. Like other departments of the Institution, the library was seriously handicapped by insufficient staff and accommodation, and overcrowding and lack of funds for binding caused progressive deterioration of its fine collections.

* Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditure and Conditions of the Institution for the Year ended June 30, 1947. (Pub. 3921.) Pp. 471. (Washington, D.C.: Government Printing Office, 1948.) 2 dollars.

IODINE AS A MEANS OF DEVELOPMENT IN PAPER CHROMATOGRAPHY

By Dr. GUNNAR BRANTE

Institute of Medical Chemistry, University of Uppsala

IN a search for an agent for revealing the position of choline and other N-methylated alkanolamines separated by chromatography on papers, iodine was found satisfactory. It can be either directly sublimed on to the dried paper or sprayed in alcoholic solution, both methods having their special advantages. During the sublimation or spraying, spots of a brown to yellow colour develop, and they grow more distinct when any excess iodine or solvent is fanned away. Inspection in ultra-violet light sometimes makes the border-lines of the spots more easily discernible. As fading rapidly sets in, the spots are best judged immediately and outlined with pencil. After some heating or hanging at room temperature, the colour of the spots caused by most substances disappears completely. New iodine treatment then again reveals them.

After disappearance of the iodine, the same paper may, without any disadvantage, be developed by some other agent, for example, ninhydrin, the hexosamine reagent according to Morgan and Elson, general sugar indication reagents (ammoniacal silver

Rf values* of some amines and amine derivatives (Munktell *MOB* paper, temp. 20–23° C.)

	Reaction to		*n*-Butanol, 40% ; ethanol, 10% ; water, 50%	*n*-Butanol, 40% ; acetic acid, 10% ; water, 50%	*n*-Butanol-phenol†
	Iodine	Ninhydrin			
I. Amino-acids					
Glycine	+	+++	0·16	0·32	0·04
Alanine	+	+++	0·22	0·39	0·09
Serine	+	+++	0·20	0·28	0·03
Threonine	+	+++	0·23	0·35	0·05
II. Amines					
Amino-ethanol	++	++	0·31	0·43	0·34
Histamine	+	++	0·32	0·25	0·73
Glucos-amine	+	++	0·30	0·28	0·09
III. N-methylated amines					
Monomethyl-amino-ethanol	++	+	0·41	0·45	0·49
Dimethyl-amino-ethanol	++	(+)	—	0·47	—
Choline	+++	—	0·19	0·45	0·45
Sarcosine	++	++	0·24	0·36	0·10
Betaine	+++	—	0·26	0·40	0·34
Acetylcholine	+++	—	0·31	0·48	0·60
Neurine	+++	—	0·23	0·46	0·55
Trimethyl-amine (-sulphate)	++	—	—	(0·43)	—
Trimethyl-amine-oxide	+++	(+)	0·36	0·54	0·61
Adrenaline	+	+	0·24	0·47	0·24
IV. Guanidine bases					
Arginine	+	+++	0·12	0·14	0·07
Guanidine	++	—	0·27	0·50	0·41
Guanidine-HAc	sl.+	—	0·21	0·39	0·12
Creatine	sl.+	—	0·22	0·37	0·11
Creatinine	+++	—	0·43	0·50	0·48
V. Purines and pyrimidines					
Adenine	sl.+	—	0·17	0·35	0·06
Xanthine	sl.+	—	0·12	0·36	0·05
Guanine	sl.+	—	0·13	0·37	0·12
Uracil	sl.+	—	0·13	0·34	0·08
Thymine	sl.+	—	0·13	0·36	0·07

* *Rf* values indicate the ratio between the distances of the substance and the solvent fronts from the initial position of the substances.

† 20 parts of water-saturated *n*-butanol mixed with 7 parts of water-saturated phenol were separated and the upper layer used in the trough.

nitrate, *m*-diphenylendjamine), picrate solution. After ninhydrin treatment, a paper may be developed by iodine (preferably by spraying) with similar results as though ninhydrin had not been used.

A great many nitrogen-containing compounds examined (in spots in most cases containing about 20–30 μgm. of substance) gave positive reactions of varying intensity and quality. I was especially interested in certain amines and their N-methylated derivatives, known or expected to be constituents of lipids. Most of the substances tested of this class gave very distinct and characteristic brown to flame-coloured spots. But various amino-acids, guanidine bases, pyrimidines, purines, etc., also were coloured, though in most cases much more faintly. Subsequent to iodine development most amino-acids gave the usual purple colour with ninhydrin; but some, for example, tryptophan, histidine and cysteine, retained iodine for a long time, thereby modifying the ninhydrin colour to a browner tint.

The method may be of value in qualitative analysis of mixtures containing only a few positively reacting substances. Thus it was found very suitable for my own purpose, namely, a study of nitrogenous constituents in lipid hydrolysates (to be published elsewhere). Data for some solvents used in these studies are collected in the accompanying table. Several other solvents have been tested and found less useful; thus it may be mentioned that in water-saturated phenol alone the methylated amines move unduly fast, and that nitrogenous solvents, due to their own reactivity with iodine, must be very thoroughly removed before iodine treatment, and therefore some of them are less convenient.

Due to their volatility, trimethylamine and dimethylaminoethanol do not appear at all, monomethylaminoethanol only with reduced strength on papers run in neutral or alkaline solvents in air. After adding one or two per cent of acetic acid to the solvent, the foregoing substances will be retained in the paper. Such solvent mixtures are now being studied.

Hitherto I have examined mainly substances which might be expected to be constituents of lipids or contaminants in lipid extracts. Purines and pyrimidines, owing to their slight solubility and faint iodine reaction, will probably not lead to errors in lipid analysis by the iodine reaction. On the other hand, the strongly reacting creatinine was identified in a distinct spot, deriving its origin from an alcoholic fraction of a lipid extract of a brain in uræmia.

In the table may be noticed several examples of the influence on its chromatographic behaviour of an OH- or CH_3-radical entering into a substance. This may be of some guidance in interpreting unknown spots.

Also in quantitative experiments with paper chromatography, iodine may prove convenient by revealing the position of the substances to be estimated; particularly as the iodine later sublimes, leaving outlined spots for excision, soaking and chemical or physical determination.

The ready formation of iodine addition compounds by amines and amine derivatives seems to be the cause of the iodine reaction, at least in most instances.

VISUAL AIDS TO EDUCATION

THE application of visual aids to education has been stimulated during the last decade mainly because the value of the still and motion picture projectors is being increasingly realized. Visual aids have existed for a long time; but it is only comparatively recently that their significance as an educational medium has been fully appreciated. This was recognized by the Havard Report on "General Education in a Free Society", which states: "Traditionally language deputises for what has to be absent. It tells us what we might see or hear. But it too often gets in the way of, or replaces, all that could give it a meaning. Now that the things and events themselves can be brought to us, the role of language is reversed. Instead of words having to explain or represent things, it is rather things or actual processes taking place before us, which explain words or call them in question."

To-day visual aids to illustrate and explain the written or spoken word are commonly used in the form of pictures, charts, diagrams and plays, while there is a growing interest in, and use of, still and motion pictures. The use of the latter in education was discussed by Mr. R. Beloe, chief education officer of Surrey County Council, in his address to the Education Section of the British Association at

Brighton. The address has now been reprinted by the National Committee for Visual Aids in Education.

Considering the place of the filmstrip projector as the successor to the old magic lantern, Beloe suggests that this device may be increasingly used, not so much as an aid to a lesson but as a lesson in itself, emphasis being placed more on the image seen than on the words read or spoken. More than the radio it could be used to project into hundreds of classrooms the identical ideas of a single teacher; every school should have its filmstrip library.

Yet however vast the potentialities of still pictures in education, those of motion pictures, which entertain for good or ill some 250 million human beings weekly, are even greater, particularly when full use may be made of natural colouring. Various investigations before 1939 recorded the value of the film in teaching. It helps children to remember; it awakens interest and secures sustained mental concentration; it stimulates, by putting a point of view different from the teacher's, and by compelling the pupil to find his own words to express opinions and to describe scenes; it supplies material for the exercise of reasoning faculties. In other words, it can enlarge the experience and broaden the outlook of pupils, and bring a sense of reality into the classroom. It can also broaden the outlook and knowledge of teachers and act as a stimulus to them.

By 1939, therefore, any doubt about the film's value as a teaching tool had vanished from the minds of those who had closely studied the matter. The real problem was one of logistics, and, until this was solved, little progress could be made.

The position was described in a 1946 report by Political and Economic Planning, from which it was made clear that there was a vicious circle. Lack of good educational films led to reluctance on the part of local education authorities to equip the schools with projectors. As there was, therefore, only a small market for educational films, it was not an economic proposition to produce them in great quantity. Recently it has been estimated that there are some two thousand instructional films of varying quality, types and value available in Great Britain. A large number of these, although for want of something better labelled as 'educational', are practically useless for teaching purposes. So far as can be ascertained, in 1946 there were fewer than four hundred sound projectors in schools in England and Wales. Of the 1,700 silent projectors available, many were unsuitable for classroom use.

These shortages of suitable films and projectors were due less to lack of enterprise than to lack of means. In the United States, where money is available, it has been stated that in the city of Los Angeles there are more than double the number of sound projectors in the whole of Great Britain. During the War the use of films by the armed forces of the British Commonwealth and also of the United States, as well as the lessons which had been gained from excellent documentary and propaganda films, again focused attention on the merit of the film as a teaching aid and on the paucity of supply.

In 1945 there was every reason on educational grounds why progress should swiftly be made in developing the use of visual aids by methods of projection as an integral part of teaching method. The lead was taken by the County Councils' Association, which, together with the Association of Municipal Corporations and the Association of Education Committees, as well as the National Teachers' Association, submitted a memorandum to the Minister of Education. As a result, two committees were set up in 1946. One, named the National Committee for Visual Aids in Education, was made up of representatives of teachers and local education authorities and had the duty of planning a visual education policy, collecting and collating views, nominating practising teachers as educational advisers to the producers of films, developing regional film libraries and encouraging authorities to purchase suitable films, advising on the supply, selection and maintenance of suitable apparatus and carrying out research. But the essence of the scheme was to be found in the Committee's relationship with the Minister. The Committee was to determine the films which are needed, and the Minister, subject to reasonable safeguards on the score of economy and the national interest, was to commission the films through a Production Committee, on which the National Committee, the producers of visual material and apparatus, the Ministry itself and the Central Office of Information were to be represented. The films thus produced were to be purchased by the authorities and schools.

At first the Central Office of Information was made responsible for the placing of films in production; but, in order that all suspicions of propaganda should be removed, it was later decided to set up a new organisation which would replace the Central Office of Information so far as educational films and other visual material was concerned. This body, the Educational Foundation for Visual Aids, is independent of the Government and has been supplied with a loan of £130,000, which is repayable to the Exchequer. Its function is, first, to market and distribute the films and other material which have already been commissioned.

Where commercial producers are prepared to take the financial risk of making a film they will be able to do so, and the Foundation will include the film in its catalogue of films, which it will supply at the stated price, receiving a discount from the production company. Where no producer is willing to take the financial risk the Foundation may either commission the film and retain the rights, or place with the producer an advance order for enough copies to enable him to finance the project. It is expected that, if necessary, the Foundation will take similar action with filmstrips.

Thus there has now been set up machinery to find out what films the schools require, for placing the work with the producers and for enabling both great and small to produce them, for providing the producers with advice from a practising teacher during production, and for marketing and distributing the finished articles.

Much more still remains to be done. First, there must be local libraries of all films likely to be in constant use by the schools, with facilities for teachers to view them. Secondly, there must be set up regional libraries for less widely required films. Thirdly, there must be a similar catalogue of filmstrips; but of these a library is needed in each school, for they are comparatively cheap and easily stored. Nevertheless, a central collection so that teachers may see what can be purchased for their schools will be needed in each authority's area.

Fourthly, the projectors for showing the material must be made available for purchase and must be purchased by local education authorities.

Fifthly, the local education authorities must make arrangements for the repair and servicing both of films and of apparatus.

Sixthly, but by no means least important, the teaching profession must be shown how to handle the medium. Up to the present the filmstrip and the film have been used mainly by enthusiasts. All teachers whose lessons can be improved by the use of visual aids should be trained to use them. It is therefore incumbent on all local education authorities to provide teachers with the facilities for acquiring that ability.

Lastly, a great deal more information based upon careful research is needed before educationists can regard themselves as masters of this medium. Scotland has produced two valuable reports which contain important statements about the subjects on which films should be made, the length of film suitable for children of various ages, and the value of sound films. These conclusions and others formulated in the 1947 Progress Report of the National Committee for Visual Aids in Education need testing. It is perhaps most important of all to ascertain the value of the film in teaching children of differing grades of intelligence and of its use in the teaching of adults.

T. H. Hawkins

SUMMER SCHOOL IN ELECTRICAL ENGINEERING AT RUGBY

DURING July 12–16, 1948, the British Thomson-Houston Co., Ltd., held, at its Rugby works, a summer school in electrical engineering, which was attended by members of the staffs of the electrical engineering departments of universities and technical colleges, together with representatives of the Service colleges, the Ministry of Education, the Institution of Electrical Engineers, and Government research organisations. In the "Proceedings" of the school, published recently by the Company, are recorded the scientific papers presented by members of the Company's staff.

These papers give an interesting cross-section of the activities of a large electrical manufacturing organisation. Materials, for example, are represented by two papers, one on magnetic sheet-steel and the other on modern developments in electrical insulators. A review is given of some of the mechanical problems affecting the design of electrical machines. Several papers deal with design problems of the magnetic and electric circuits of rotating electrical machinery and one with the design of insulation for high-voltage transformers. Power systems receive attention in papers on switchgear, protective gear and power system analysis. Rather more than half the papers are concerned with electronics or high-frequency phenomena and applications. The fundamental theory of communication forms the subject of one paper, and magnetron generators, pulse modulators and micro-wave transmission techniques are covered by a group of papers. In the field of electronics there are contributions dealing with fluorescent discharge-lamps, arc control in gas-filled valves, the application of the mass spectrometer to leak detection in high-vacuum systems, and a development of the betatron.

One of the most valuable features of this collection of papers is the indication given in many of them of the trend of development and of the directions in which research in university departments could contribute towards the solution of some of the more fundamental problems. Having regard to the fact that these lectures were prepared by members of design and development departments as well as of the research department, it is perhaps worth while to record the impression that the scientific requirements of design and development are scarcely less stringent than those of research. Of particular interest is the opening address given by Sir John Cockcroft, in which the needs of Great Britain for scientific and technical staff are reviewed.

THE AGORA OF ANCIENT ATHENS: A STUDY IN ARCHÆOLOGICAL RECONSTRUCTION*

By Prof. HOMER A. THOMPSON
Institute for Advanced Study, Princeton

THE excavations which are being currently conducted by the American School of Classical Studies in the Agora, or civic centre of ancient Athens, have led to the identification and restoration of many ancient buildings through the combination of evidence drawn from ancient authors, inscriptions and the exploration itself. As a specimen to illustrate the procedure, the Odeum, or Concert Hall, may be selected.

The remains of the Odeum have been identified from a reference in Pausanias, the 'Baedeker' of the second century. Its date of construction is fixed in the Augustan period, partly by its architectural style, partly by the pottery associated with its foundations and partly by its specific name, the Agrippeum, which suggests that the building was erected by Agrippa, the minister of Augustus.

A close study of the foundations of the building and of scattered marble blocks from its superstructure has permitted the recovery of its architectural scheme in all essentials. The building proves to be unique in its dual nature, comprising as it did a core, in which were an auditorium, stage, dressing-room and lobby, and around the core a raised balcony that opened outward for the accommodation of spectators who might wish to view processions or ceremonies in progress outside the building. Of particular interest among the architectural details of the original period is the stage front, which was decorated with a marble screen supported by terminal figures alternately male and female.

The siting of the building on the axis of the Agora square is reminiscent of the contemporary Forum of Augustus in Rome, while its scheme of lighting through an open colonnade at one end was inspired by the Erechtheum; hence its design may be the work of a team of architects, some Greek and some Roman.

The building collapsed and was afterwards remodelled (as shown by stamped roof tiles) about A.D. 150. The remodelling involved reduction in the capacity of the auditorium from 1,000 to 500, and in the conversion of the original dressing-room into

* Abstract of a Friday Evening Discourse delivered at the Royal Institution on February 18.

an open porch. The entablature of this porch was supported by six colossal marble figures, half of them Tritons and half Giants, both types being adaptations from statues of divinities in the pediments of the Parthenon. In front of the pedestals of these colossal figures were placed seated statues of philosophers. From the radical changes involved in the remodelling and from the fact that Philostratos (writing in the late second century) referred to the building as the scene of public lectures by the sophists, it may be inferred that in its second period the Agrippeum had become a university lecture hall and that its function as a concert hall had been assumed by the great new Odeum erected by Herodes on the south slope of the Acropolis about A.D. 160.

A century later (A.D. 267) the Agrippeum was burned down by a band of barbarians, the Heruli, who sacked this part of Athens. The area lay desolate until about A.D. 400. Then above the ruins of the ancient building was erected a huge complex in the nature of a gymnasium which, in accordance with the Greek practice, would also have served university purposes. In the façade of the new building were incorporated four of the colossal figures from the old. The great structure of A.D. 400 was abandoned in the sixth century, presumably in consequence of the Emperor Justinian's edict closing the University of Athens (A.D. 529), and its ruins were buried by silt. Early in the nineteenth century three of the colossal figures were rediscovered and later re-erected, to be known as the 'Stoa of the Giants', one of the most prominent landmarks in the city and one of the most enigmatic until its riddle was solved by the current excavations.

TRAINING FACILITIES IN INDUSTRIAL RADIOLOGY

THE need for extending the available training facilities in industrial radiology was discussed at a meeting of the Industrial Radiology Group of the Institute of Physics held on February 18, at which were representatives of inspecting authorities, technical institutions, the Ministry of Education and industrial firms.

Discussing the necessity for adequate training of industrial radiographers, Mr. J. C. Rockley (Aeronautical Inspection Department) explained the system adopted by the Department, by which certain industrial radiographic departments and the radiographers in charge are 'approved' after satisfying the Aeronautical Inspection Department that the apparatus available is satisfactory for the intended purpose and that the radiographer has received sufficient basic training to be competent. A feature of this system is that if the radiographer moves to another department, his 'approval' is automatically withdrawn; the 'approval' of the department would also be withdrawn pending the appointment of a qualified successor.

Mr. F. C. Cocks (Lloyd's Register of Shipping) explained that the principal requirements for surveyors and other officers of inspecting authorities are provision for acquiring the technical background and experience in interpretation of radiographs necessary to satisfy themselves on the quality of the radiographic examination, and to assess the effect on the structure examined of an internal defect the shadow of which is seen on the radiograph.

Mr. F. Y. Poynton (Northampton Polytechnic, London) reviewed the present position with regard to technical institutions. Only very few technical colleges—among them the Northampton Polytechnic, London; the Royal Technical College, Glasgow; and the technical colleges at Chesterfield and Wednesbury—possess X-ray apparatus suitable for radiography, and none of these has equipment operating above 100 kV. peak. Most of the industrial radiography carried out, however, falls within the range of 150–400 kV. peak, or utilizes gamma-radiation; and it is under these conditions that most of the practical problems associated with scattered radiation, radiographic sensitivity and protection occur. Mr. Poynton said that steps are being taken to provide facilities for training in industrial radiography at the Northampton Polytechnic, London. The detailed form of these courses has still to be worked out; but considerable progress has been made in the provision of apparatus and the necessary laboratory and darkroom equipment.

Dr. L. Mullins described the courses being run by Kodak, Ltd., and explained that the basic introductory course occupies two weeks (75 hours) with an optional third week. This period has been adopted as the minimum in which the fundamental theoretical and practical training can be given, and because industrial firms are generally reluctant to release their staff for a longer period. He also mentioned more advanced courses in casting and weld radiography, lasting two weeks, and in shipbuilding radiography occupying three weeks.

Mr. N. Tunstall (Ministry of Education) said that the Ministry is anxious to participate so far as the demand for training facilities justifies; but it is very desirable that industry should make clear to local colleges the extent and nature of the demand for such facilities. The provision of short intensive courses would be a departure from the more usual method of training in a 'laboratory art', which is usually catered for by a course of part-time study lasting two years. The question of awarding a certificate of competence at the end of a full-time course of two or three weeks duration is one requiring a particularly cautious approach. H. S. TASKER

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, April 23—Saturday, April 30

UNIVERSITY OF LONDON (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 10 a.m.—Public Exhibition of "European Housing in Prehistoric Times".*

Monday, April 25

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Prof. Adrien Albert: "Selective Toxicity with special reference to Chemotherapy".* (Further Lectures on May 2, 9, 16, 23, 30 and June 8 and 13.)

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Mr. H. C. Walker: "Present Century Advance in Marine Engineering Science" (Science and Marine Navigation, 3).

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND S.E. COUNTIES SECTION (at Medway Technical College, Gardiner Street, Gillingham), at 7.30 p.m.—Mr. P. H. Prior: "Some Experiences of a Chemist in the Paper Industry".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8.15 p.m.—Prof. George B. Cressey: "China's Prospects".

Tuesday, April 26

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. J. G. Peristiany: "Social Structure of the Pokot (Suk)".

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. Harry Milligan: "South Devon Story".

INSTITUTION OF THE RUBBER INDUSTRY, LONDON AND DISTRICT SECTION (at Caxton Hall, Caxton Street, London, S.W.1), at 7 p.m.—Annual General Meeting; Dr. L. R. G. Treloar: "Rubber Physics Up-to-Date".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 7 p.m.—Dr. K. Hoselitz: "Permanent Magnet Alloys".

Tuesday, April 26—Friday, April 29

INSTITUTE OF WELDING (at Beach Hotel, Southsea).—Spring Meeting.

Wednesday, April 27

TEXTILE INSTITUTE (in the Public Hall, Lune Street, Preston), at 10 a.m.—Annual General Meeting; Sir Frederick Bartlett, F.R.S.: "The Application of Psychology to the Textile Industry" (Mather Lecture).

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (at the British Oxygen Co., Research and Development Department, Lombard Road, Morden Factory Estate, Morden, London, S.W.19), at 2.30 p.m.—Dr. P. H. Sykes: Introductory Lecture; Dr. P. M. Schuftan and Mr. A. M. Clark will outline the work of the Development and Research Sections respectively.

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Annual General Meeting; Prof. H. H. Read, F.R.S.: "Time in Plutonism" (Presidential Address).

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. J. Bronowski: "Some Uses of Statistics in the Building Industry—an Investigation into the Erection Times of Nine Types of Non-Traditional House".

INSTITUTION OF ELECTRICAL ENGINEERS, NORTH-WESTERN RADIO GROUP (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Discussion on "Audio-Reproduction" (to be opened by Mr. G. J. Scoles, Mr. A. G. F. Smith and Mr. G. I. Thomas).

ROYAL STATISTICAL SOCIETY, NORTH-EASTERN GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (at the Chemical Industries Club, 18 Lovain Place, Newcastle-upon-Tyne), at 6.30 p.m.—Mr. N. J. Squirrel: "Statistical Tables in Quality Control".

INSTITUTE OF INDUSTRIAL ADMINISTRATION, MANCHESTER CENTRE (in the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Mr. J. N. Toothill: "Productivity of the Engineering Industry".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Lawrence Bragg, F.R.S.: "Giant Molecules".

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1).—Conference on "Combined Heat and Power Supplies".*

Thursday, April 28

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Exhibition Meeting.

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. G. Polya: "Symmetrization".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Dr. Hugh Dryden: "The Aeronautical Research Scene—Goals, Methods and Accomplishments" (Thirty-seventh Wilbur Wright Lecture).

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.15 p.m.—Scientific Papers.

BRITISH INSTITUTE OF RADIOLOGY (at 32 Welbeck Street, London, W.1), at 8.15 p.m.—Dr. F. G. Spear: "The National Radium Commission in Retrospect" (Silvanus Thompson Memorial Lecture).

Friday, April 29

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Presentation of James Watt International Medal, and Special Lecture by the recipient, Dr. Fredrik Ljungström of Sweden.

ROYAL STATISTICAL SOCIETY, BIRMINGHAM GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (in the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Mr. E. D. van Rest: "Sequential Sampling".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN CHEMISTRY—The Principal, Wigan and District Mining and Technical College, Wigan (April 29).

PHYSICIST—The Secretary, Romford Group Hospital Management Committee, Oldchurch Hospital, Romford, Essex (April 30).

LECTURER IN CHEMISTRY—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham (April 30).

DIRECTOR OF RESEARCH (to be responsible for the control of technical research under the headings of Engineering, Metallurgy, Chemistry, Textiles, Paints, etc., as well as General Research)—The Secretary, Railway Executive, 222 Marylebone Road, London, N.W.1 (April 30).

ASSISTANT LECTURER or LECTURER (Grade II) IN BOTANY (Plant Physiology)—The Registrar, University College, Southampton (May 1).

LECTURER or ASSISTANT LECTURER IN MATHEMATICAL STATISTICS, and an ASSISTANT LECTURER IN APPLIED MATHEMATICS—The Registrar, The University, Liverpool (May 1).

LECTURER (Grade I or Grade II) IN PHYSICS—The Secretary, The University, Birmingham 3 (May 1).

ASSISTANT DIRECTOR—The Director, Solar Physics Observatory, Cambridge (May 4).

LECTURER IN EDUCATION (with qualifications in Science, preferably Chemistry or Biology), an ASSISTANT LECTURER IN PHYSICS, and an ASSISTANT LECTURER IN MATHEMATICS—The Registrar, University College, Leicester (May 7).

MATHEMATICIANS, PHYSICISTS and AERONAUTICAL ENGINEERS (unestablished Senior Scientific Officer and Scientific Officer grades) at the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.438/48A (May 7).

PROFESSOR OF BOTANY—The Secretary, University College, Cork (May 7).

LECTURER (on probation) IN THE DEPARTMENT OF ZOOLOGY AND COMPARATIVE ANATOMY—The Registrar, University College, Cathays Park, Cardiff (May 12).

ASSISTANT LECTURER (temporary) IN AGRICULTURAL ZOOLOGY—The Secretary and Registrar, University College of North Wales, Bangor (May 15).

ORGANIC CHEMIST as research assistant to the Professor of Medical Chemistry, Australian National University, Euston Road, London, N.W.1—The Administrative Office in the U.K., Australian National University, Africa House, Kingsway, London, W.C.2 (May 19).

HEAD OF ESTABLISHMENT (male) at the Air Ministry Survey Production Centre, Teddington—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2508 (May 19).

LECTURER (Grade III) IN ELECTRICAL ENGINEERING—The Registrar, Queen Mary College, Mile End Road, London, E.1 (May 20).

UNIVERSITY DEMONSTRATOR IN METALLURGY—The Secretary, Appointments Committee of the Faculty of Physics and Chemistry, University Chemical Laboratory, Pembroke Street, Cambridge (May 21).

JUNIOR LECTURER IN MATHEMATICS—The Secretary, University Registry, Oxford (May 23).

CHAIR OF GEOGRAPHY at the London School of Economics and Political Science—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 25).

CHAIR OF BOTANY at Royal Holloway College, Englefield Green—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 30).

LECTURER (with qualifications in Electronics) IN THE FLUID MOTION LABORATORY—The Registrar, The University, Manchester 13 (May 31).

DEMONSTRATOR IN THE DEPARTMENT OF ENTOMOLOGY—The Assistant Dean, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1 (May 31).

NUFFIELD STUDENTSHIPS AND FELLOWSHIPS for experimental and theoretical research in Nuclear Physics—The Professor of Natural Philosophy, The University, Glasgow, W.2 (May 31).

HOME OFFICE INSPECTORS (2) under the Cruelty to Animals Act 1876 (experiments on living animals)—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 2504 (May 31).

LECTURERS and SENIOR LECTURERS IN PHYSICS—The Secretary of University Court, The University, Glasgow (May 31).

LECTURER IN PHYSICS—The Secretary, The University, 38 North Bailey, Durham (May 31).

LABORATORY STEWARD IN THE PHYSICS DEPARTMENT—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18.

LECTURER IN CHEMISTRY—The Registrar, Municipal College, Portsmouth.

FISHERIES OFFICERS in the Federation of Malaya, and in East and West Africa—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

ABSTRACTORS to deal with technical and scientific literature relating to textiles, and a LIBRARIAN—The Director, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

TECHNICAL ASSISTANTS in Royal Ordnance and Atomic Energy Factories and other Establishments, for investigation (under direction of senior engineer or chemist) of problems connected with either the production, development or maintenance and service sides of the factories and preparation of reports—The Ministry of Supply, Est.2(E)1, Room 403, Adelphi, London, W.C.2.

TECHNICIAN (mainly to assist in research work) IN THE DEPARTMENT OF EXPERIMENTAL PHYSIOLOGY—The Professor of Physiology, Medical School, Newcastle-upon-Tyne.

ASSISTANT LIBRARIAN—The Secretary, British Internal Combustion Engine Research Association, 111–112 Buckingham Avenue, Slough, Bucks.

JUNIOR CHEMISTS or PHYSICISTS to supervise work involving chemistry and/or applied physics in the Division of Atomic Energy (Production) at Springfields Factory, Salwick, Lancs., and Windscale Works, Sellafield, Cumberland—The Staff Section, Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington.

RESEARCH WORKER to conduct experiments in the biological aspects of 25 MeV. X-Rays and electrons—The Director, Cancer Clinic, City Hospital, Saskatoon, Sask., Canada.

EXPERIMENTAL OFFICER for two years' research on the physics of the pick-up of airborne droplets by flying locusts—The Director, Anti-Locust Research Centre, British Museum (Natural History), Cromwell Road, London, S.W.7.

PHOTOGRAPHER for medical (non-clinical) and scientific work—The Secretary, Department of Physiology, School of Medicine, Leeds 2.

GRADUATE CHEMIST for work on the development of the use of wool grease and its by-products in the leather industry—The Director of Research, British Leather Manufacturers' Research Association, 1–6 Nelson Square, London, S.E.1.

PHYSICIST, CHEMIST, or ENGINEER, to be responsible for the measurement and control of radiation hazards throughout the factory area, in the Division of Atomic Energy, Windscale Works, Sellafield, Cumberland—The Ministry of Supply, Division of Atomic Energy, Risley, Warrington, Lancs.

CHEMISTS (2) for research concerned with the control of agricultural pests by chemical means, particularly by soil fumigation—Dr. A. B. P. Page, Imperial College Field Station, Silwood Park, Sunninghill, Berks.